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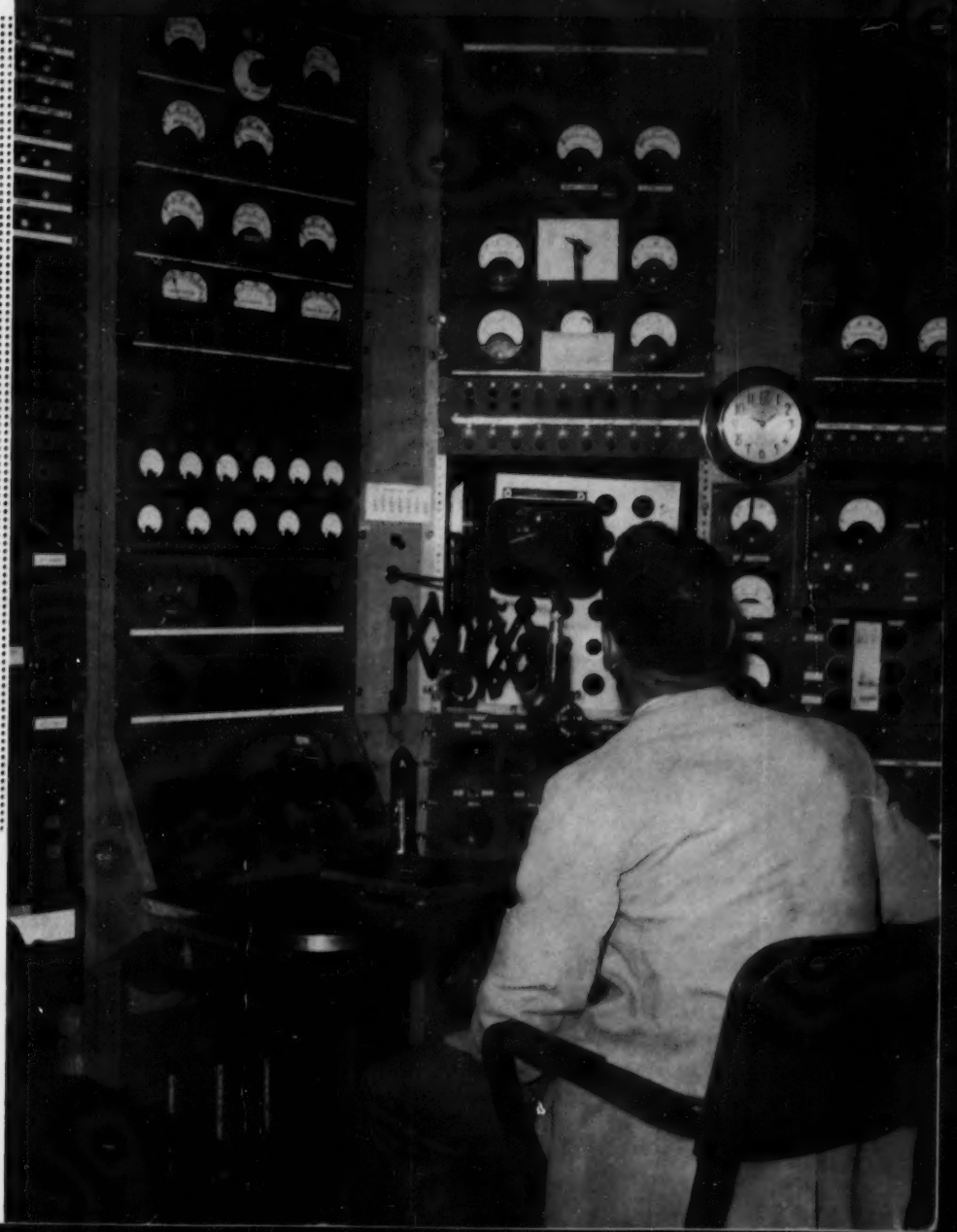

MARCH, 1956
VOL. 21, NO. 6
25 CENTS

James Chisholm, class of '41,
speaks from experience when he says,

"Men with ability and ambition really have a chance to get ahead at U.S. Steel"

● A responsible position can come quickly to those graduate engineers at U.S. Steel who show ability and ambition. Management training programs are designed to stimulate and develop these qualities as the trainee "learns by doing." His training is always a fascinating challenge and he works with the best equipment and the finest people in the business.

James Chisholm is typical of the young men who rapidly rise to an important position at U.S. Steel. Jim came to U.S. Steel as a trainee in 1941 after graduating as an M.E. Shortly thereafter he entered military service for four years. Upon his return to U.S. Steel in 1946, he advanced steadily until, in 1951, he was appointed to his present position as Assistant Superintendent of Blast Furnaces at the new Fairless Works at Morrisville, Pa.

Jim is now in charge of quality control for open hearth furnaces at Fairless, the unloading of all ore ships and the operation of the plant's two big blast furnaces—each with a rated output of 1500 tons per day.

Jim feels that the opportunities for graduate engineers are exceptional at U.S. Steel. He remarked that in his own department alone, six college trainees have been put into management positions within the last couple of years. He says that chances for advancement are even better now with the current expansion of facilities and the development of new products and markets.

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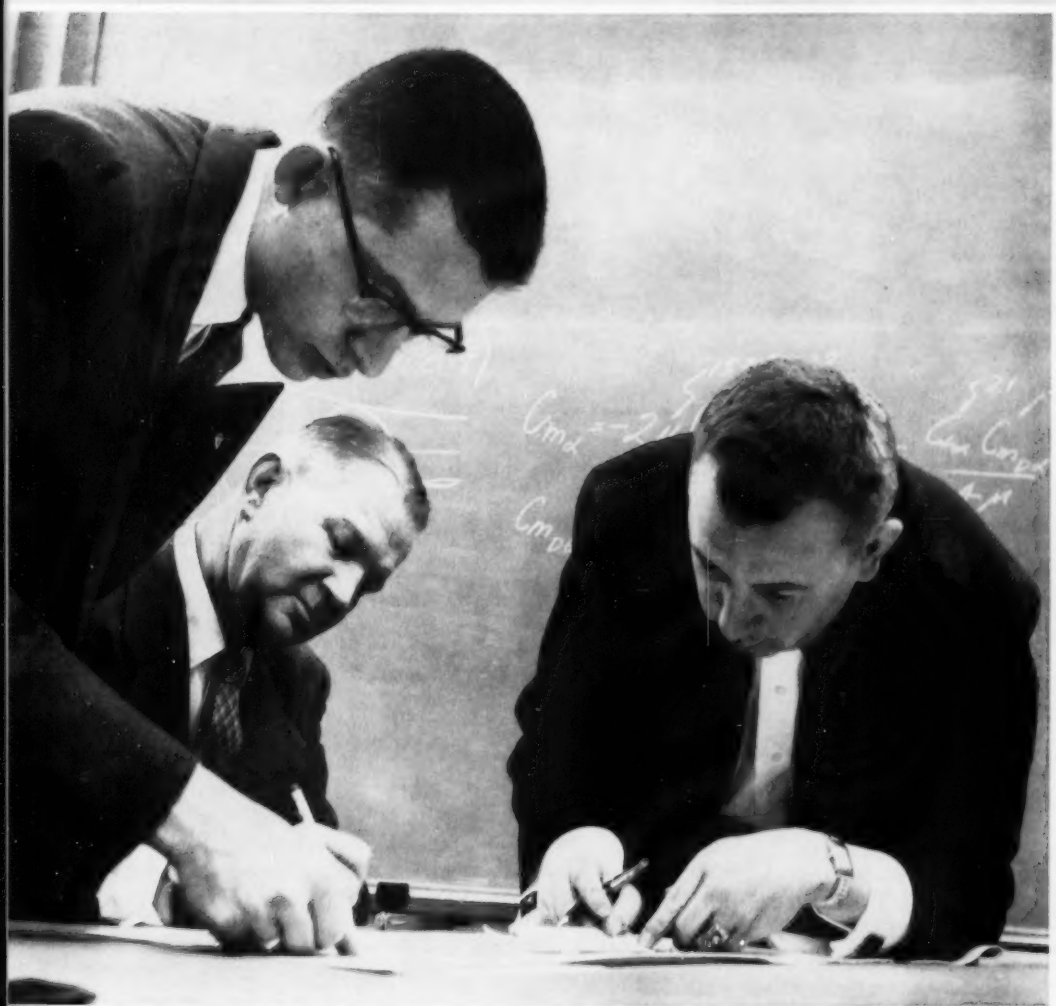
SCIENCE AND ENGINEERING

AT LOCKHEED MISSILE SYSTEMS DIVISION



Dr. W. S. Wunch, research specialist in aerodynamics, A. C. Ballaseuys, research engineer, and R. S. Swanson, areodynamics department manager, determine stability derivitives of a high speed missile from flight records.

THE CREATIVE APPROACH TO MISSILE SYSTEMS FLIGHT TEST ANALYSIS

The work of the Aerodynamics Department of Lockheed Missile Systems Division requires a creative approach to flight test planning and analysis. Consequently, research as well as development studies are carried on in flight determination of the performance, stability, control, flutter, aeroelastic, and aero-thermodynamic characteristics of missile airframes.

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3 The development of mathematical and physical analogs for prediction and data for missile performance, control, flutter, aeroelastic and thermal studies.

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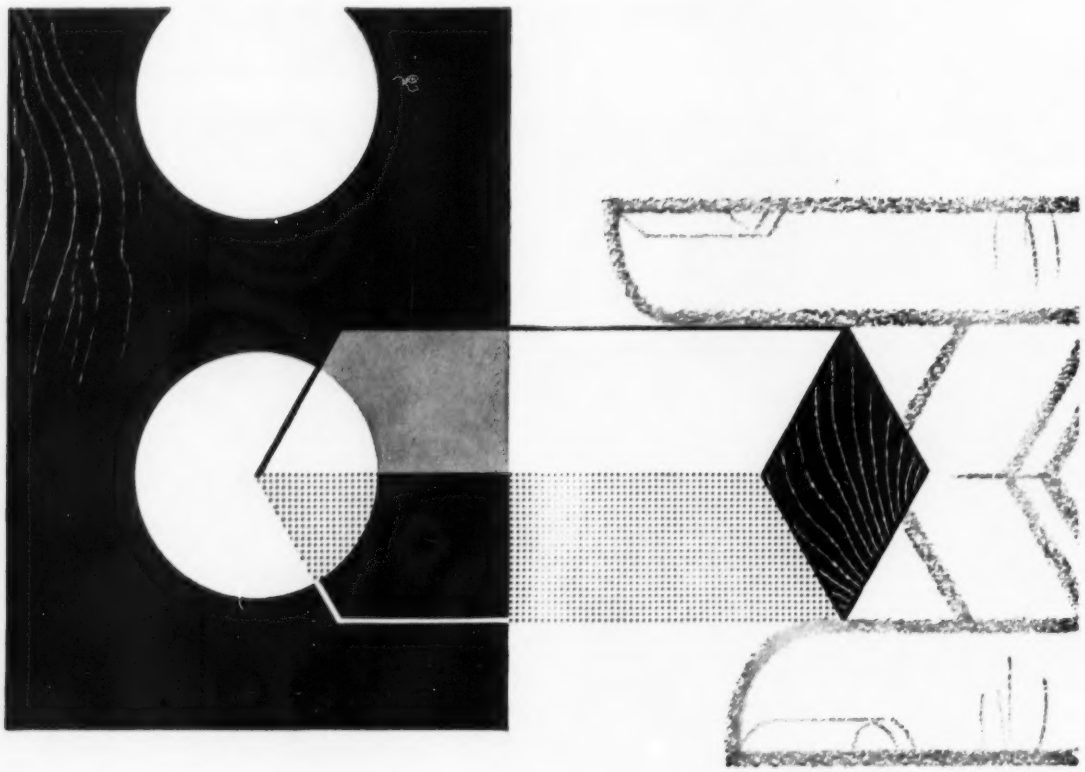

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EVERY on-his-toes engineering senior knows that his first job is a most important one.

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Self Service Means Responsibility

The staff of the CORNELL ENGINEER has set up unattended tables in the engineering buildings for the past several months to sell the magazine. A student has only to drop a quarter in the coin box provided he wants a copy. We believe that students appreciate the chance to glance through the magazine and buy a copy if they choose, and the fact that a considerable number of copies are sold each month from the tables indicates that this is true.

We have had a serious problem to face in connection with these unattended tables. Each month a considerable number of magazines have been stolen, often nearly 20% of the copies put out on the stand. In the sale of the January issue, several of the coin boxes (which cannot be locked) were opened and the money inside was stolen.

Selling the CORNELL ENGINEER in this manner requires a high standard of personal honor on the part of the student body. There are no proctors or written standards of moral obligation. We believe that as a group Cornell students are honest, and that only a very few are doing the actual stealing.

However, dishonesty of this sort thrives when the general attitude is "I didn't do it!", rather than "How can we stop this sort of thing?" An honor system certainly would not work if the first attitude continues to be widespread.

The staff of the Cornell Engineer would like to continue selling the magazine at unattended tables in the engineering buildings each month, but we cannot do so unless recent losses are drastically reduced. We would like to have this selling system serve as a working example of the personal integrity of all Cornell students.

D.H.

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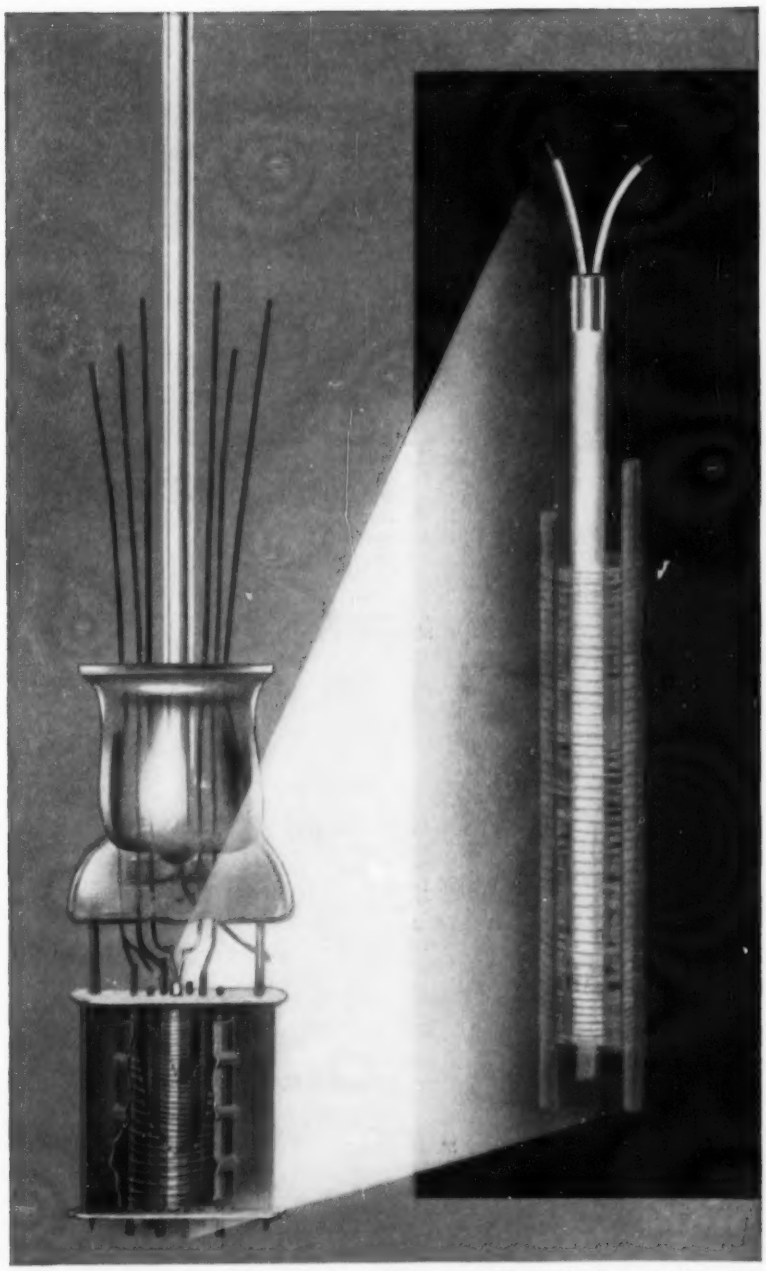

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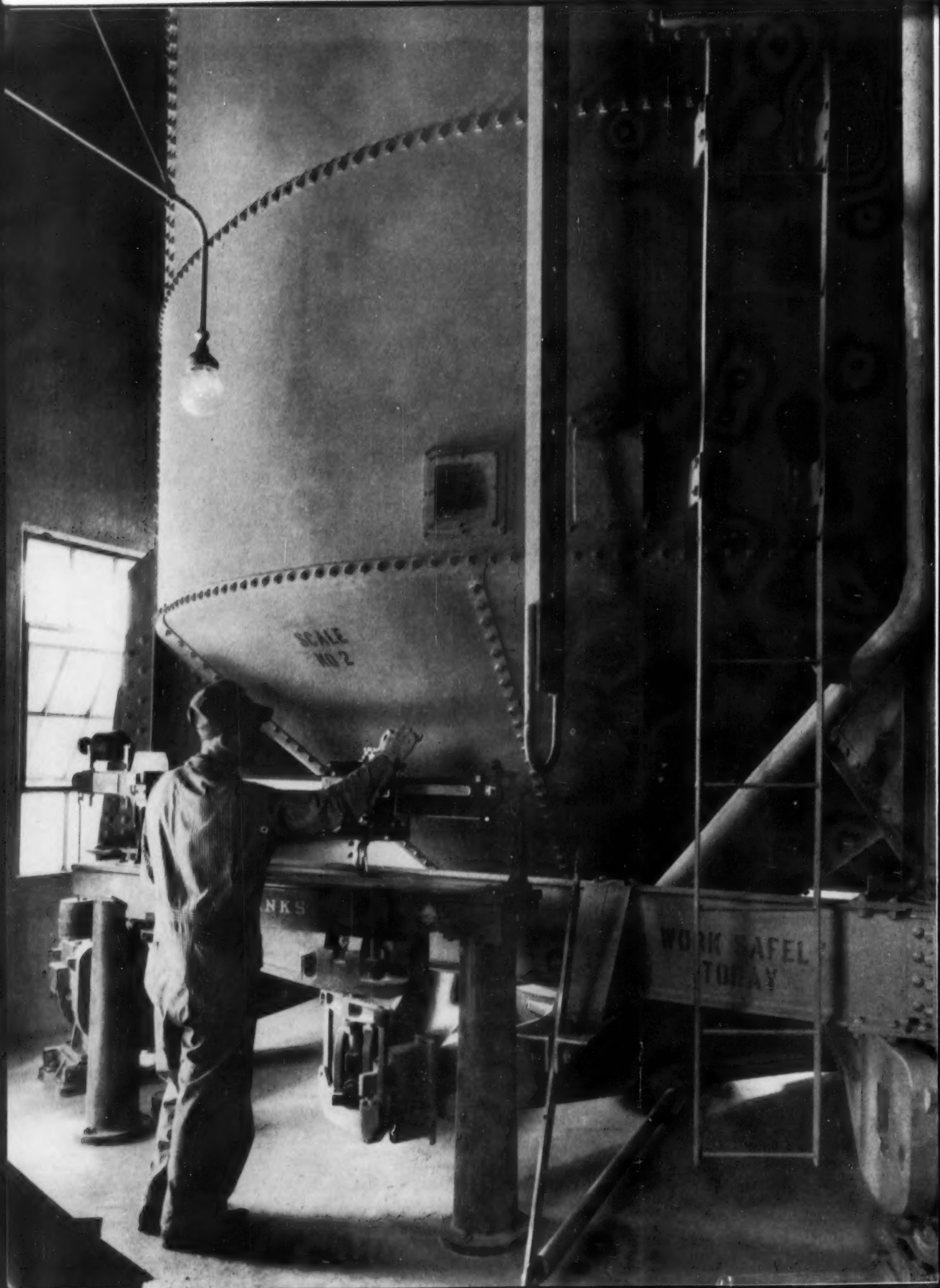

SCALE
NO 2
WORK SAFEL
TODAY

MALTING . . .

by

LAVONNE O. TARLETON, ChemE '57

(Photos courtesy of Rahr Malting Co.)

Malting is an ancient art. The Egyptians were the first to record the use of malt for the production of beer and other fermented beverages. The earliest settlers of North America brought barley with them to be used principally for the production of malt for the making of beer. Today, the malting of barley and other cereal grains is an extensive industry. Over 100,000,000 bushels of barley alone were malted in the United States in 1949.

The uses of malt are based chiefly on enzyme activity, starch content, and flavor. Normally, 83% of the malt produced goes into beer and ale, all three properties are important. In brewing, malt makes up from 50 to 70% of the total quantity of materials used.

The next largest use of malt is in the manufacture of industrial alcohol and whiskey. About 10% of the malt production goes into this distillers' malt. For alcohol production, the enzyme content is of major importance, while flavor assumes some importance in whiskey manufacture. In both of these uses 10 to 15% of malt is used in the mash to convert starch to fermentable sugars, which are then fermented to alcohol.

The other 5 to 10% of malt production has a variety of uses. The third largest use is in malt syrup manufacture, the syrups being used for baking, textile desizing, medicine, candy and breakfast cereals. Malted milk concentrates are used for infant foods and flavoring, malt flour is used for animal feed. Special malts are used in coffee substitutes and dark beer, their use depending on color and flavor.

Scale for weighing-in barley.

Economic Aspects

Malt is essentially an intermediate product requiring reprocessing or incorporation by industries utilizing it in the preparation of finished products. Thus, the total quantity of barley malted in the United States varies from year to year, depending upon suitablity of material available for processing and the demand for malt. Over the last ten years there has been a gradual increase in the production of malt. The estimated malting capacity is now 12,000,000 bushels. Moderate expansion of that capacity is now in progress.

Thirty to forty per cent of the barley produced in the United States is used for malting. More than 90% of the malt produced is made from midwestern six-row barley and less than 10% from western barley.

Since the investment in processing equipment for pneumatic-type malting is large, there are few small malting companies. The increase in malt production thus results from expansion of existing companies.

The Malting Process

Malt is the product of the germination of cereal grains controlled to limit sprout and rootlet development. Briefly, the process of malting consists of steeping selected barley in water to activate the dormant embryo plant in each grain, allowing the wet grain to germinate to the desired degree, and kilning to stop growth.

The malting process itself and the accompanying physical and chemical changes can be discussed best in chronological order.

Cleaning and Sizing

Since most of the malt produced is for human consumption, cleaning becomes an important step in the handling of the barley. The incoming barley is separated from dirt, weed seeds, and seeds of other grains before being stored. At the same time, the small-kernel barley is also removed and sold as feed for livestock.

During the cleaning process, the barley is separated into several sizes on the basis of width of the kernel with a ring grader. The size of the kernel influences the rate of water absorption during steeping and germination, and loss of moisture during kilning. Thus, the separate sizes are stored and malted separately.

The cleaned barley is then stored under cool and dry conditions for six weeks to several months. Freshly harvested barley is often dormant or will show low, uneven germination. While in storage, the barley goes through an after-ripening process during which still obscure chemical and physical changes take place. Physical changes in the permeability of the enclosing membranes of the seed coat permit the access of oxygen and dormancy disappears. Also during storage all of the barley attains uniform moisture content which contributes to uniformity of steeping. Moisture content and temperature control of the grain is carefully controlled. Temperature-recording devices are placed several feet apart in the elevators and conveyors used in handling the grain, and in the storage bins. The stored barley is checked periodically for percentage germination to determine scheduling for steeping.

Steeping

Cylindrical steel tanks with conical bottoms are used for steeping the barley. The tanks have a capacity of 600 to 700 bushels for drum

malting plants and up to 2500 bushels for compartment plants. The tanks have overflow facilities, water supply pipes, and compressed air inlets which permit vigorous stirring and aeration of the barley in the water.

Steeping temperatures are normally 50 to 60°F. Often a small amount of lime is added to the first steep water to improve the appearance of the finished malt and to dissolve out undesirable constituents of the barley hull. The compressed air loosens dirt and foreign material from the grains. The dirt is removed by overflowing. After 8 to 10 hours, the steep water is changed. Between water changes a rest without water is practiced by many maltsters.

The rate of water absorption and time of steeping are influenced by temperature, size of kernel, type and variety of barley, and physical texture of kernel. By steeping to a uniform intermediate moisture content of 44-45%, uniform germination of the desired type results.

The changes that occur to the grain during steeping are understood. A small quantity of soluble material is extracted from the kernel. As moisture content increases, respiration of the grain increases very rapidly. For this process, oxygen is absorbed from the water and replaced by the carbon dioxide given off, creating the need for aeration and frequent changes of steep water. With vigorous aeration, germination may start in the steep and rest following steeping and thus shorten the time for the malting process.

Germination

Pneumatic-type malting in which conditioned air is forced through the germinating grain is used almost exclusively in the United States. Two types of equipment, drum and compartment, are used extensively, although considerably more malt is produced in compartments than drums.

The drums have a capacity of 600 to 700 bushels of barley. The drum revolves very slowly, either continuously or intermittently, to stir the barley. Conditioned air is distributed through the mass of germinating barley. In these ways, temperature and moisture content can be controlled. Openings for loading and unloading the drum are located around the circumference and, when germination is complete, the moist germinated barley called green malt is dumped on a conveyor and carried to the kiln.

The compartments are large, rectangular concrete boxes with a capacity of 1500 to 5000 bushels. To control conditions, the attemperated air is drawn down through the germinating grain and on through the perforated metal bottom of the compartment. A depth of 18 to 30 inches of barley is maintained. A turning device consisting of a row of spiral helices levels the grain after loading and stirs the grain during the process.

The air used is brought to the proper temperature and saturated with water vapor. Various air conditioning methods are employed.

The germination process varies considerably from plant to plant and also with the type of barley used and the type of malt being produced. The discussion will be limited to average conditions. Conditions essential for germinating are optimum moisture content, temperature, adequate oxygen supply, and sufficient time.

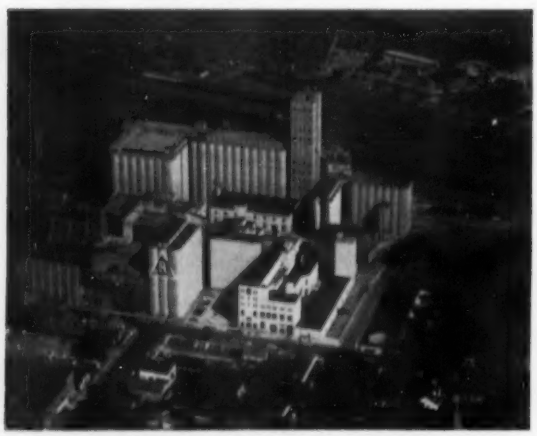
Relatively low germination temperatures are required to reduce the loss of dry material through respiration and growth of rootlets and still bring about the desired physical and chemical changes. The range of 60 to 70°F. is used, the temperature being varied within the maximum and minimum according to the response of the barley.

Oxygen is required by the germinating grain for respiration and carbon dioxide is evolved. Aeration supplies oxygen, prevents accumulation of detrimental quantities of carbon dioxide, and controls temperature by removing heat of respiration and germination.

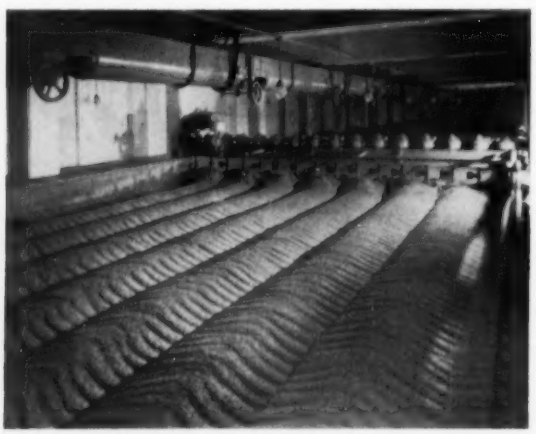
In American practice, the time of germination varies from five to seven days. European malting methods require from seven to ten days at lower temperatures for the two-row barleys used. In the United States, the higher nitrogen six-row barleys require less time.

The physical and chemical changes during germination are a continuation and extension of those started in the steep.

The most important enzymic constituents of malt are the starch-splitting enzymes or amylases. The



General view of malting plant.



Germination compartment.

Discharging roasted malt from roasting ovens into cooler.

Checking temperature in steep tanks during aeration.

amylases hydrolyze part of the starch in the endosperm cells to soluble sugars. Some of these sugars then diffuse into the germ and serve as a source of energy and building material for growth.

Conditions under which germination occurs affect the enzymic activity, so that control is essential for a uniform product.

Kilning

When germination has progressed to the proper stage, the malt is transferred to the top floor of a kiln. The kilns have two or three levels. Heated air is passed up through the several levels and the malt is dropped progressively from the top to the bottom floor as drying takes place. The finishing for brewers' malts takes place on the lower level at temperatures of 180°F. Since it is undesirable to heat the malt on the upper kilns to high temperatures when the moisture content is high, many kilns bypass the hot air or mix cool dry air with the hot air before it reaches the upper level.

Kilning gradually stops germination, but some growth, development of enzymes, and hydrolysis of constituents continue during the withering process. Further drying results primarily in loss of moisture. The high temperature final drying step results in chemical changes that impart aroma and flavor to the kilned malt. Enzyme destruction also occurs due to the high temperatures, so that development of flavor must be balanced against destruction of enzymic activity.

The malt is stored from six weeks to several months before blending and shipping. During storage, a uniformity of moisture content develops. The rootlets are removed and the malt cleaned before blending.

By-products are of minor importance. The barley grains too small for malting are sold as animal feed. The malt sprouts, which are primarily rootlets, comprise three to five per cent of the weight of the grain, and are sold for their readily available forms of nitrogen. Malt sprouts average 27% protein and are used in dairy feeds.

European Malting

The European methods of malting are interesting in comparison with those in the United States. Some malthouses employ modern techniques, but many still use the old method of "floor malting." In floor malting, grain is removed from the steep tanks and spread on floors to germinate. The floors are ordinarily stone, concrete, or tile, and a malthouse usually has several stories of such floors. The grain is piled sixteen to twenty inches deep and allowed to stand a day until the temperature rises to about 60°F. Then the grain is spread into a layer three to six inches deep. It is turned occasionally by hand to ensure uniform germination. Air is supplied by opening the windows, causing the weather to have an important affect on the germination.

The process is controlled by opening or closing the windows and by varying the depth of grain on the floor. This method of control forces malting to be a seasonal operation, confined to the cooler months.

Process Control

The only true method of testing the quality of malt produced is by examining the end product, beer. Pilot-scale malthouses and breweries are being used to a considerable extent by malthouses in the United States to better control their product and to aid in making blends of malts to satisfy customer's specifications.

The pilot malthouses consist of a steeping unit, a germinating unit, and a kiln. Usually two-pound samples of barley are malted at a time.

Pilot brewing parallels commercial processes. The capacity is in the range of five gallons of wort beer per brew. There are two identical brewing units so that a control brew can be made for comparison in conjunction with a test brew. The cereal cookers, mash tubs, lauter tubs, brewing kettles, hop strainers, and wort tanks for both systems, together with the cooler common to both, are mounted on the wall of the laboratory. Wherever possible equipment is constructed from stainless steel.

Pilot malting and brewing studies are being carried out by such organizations as the Malt Research Institute of Madison, Wisconsin. Through their work, substantial progress in malting and brewing technology is being made and improved strains of barley are being developed.

Engineers With Supervisory Knowhow

by O. K. BURROWS

Director of Personnel Administration
Cherry Burrell Corporation

Manpower is critically needed today. Every metropolitan newspaper shows top management crying out for good administrative technical leaders. They need good supervisors at once, but the training of good technical supervisors is not easy. How is it done? Usually, a man of promise with either sparkling personality or a good record as an individual worker is finally selected from a list of possible candidates. Notice is posted saying that "Mr. Blank, as of the first of next month, will be the head of a certain technical work group". Usually, full cooperation of fellow workers is solicited.

However, unless the company has a supervisor's training program in the broad field of human relations, the man selected is seriously handicapped. True, he has exactly the same education, work experience, temperament, beliefs and prejudices that he had the day before his selection was announced. He must now learn what it is that motivates others to do things he desires done. The posted announcement did not necessarily make him a supervisor, it only gave him the privilege of earning the right to be an administrative leader.

In recent years, this critical need for good technical administrative supervisors has been paced by the tremendous growth in industrial design, research, production, engineering and distribution in a hundred scientific fields. Thousands of engineers today—and thousands of undergraduates struggling with their courses—have taken up or will take up responsibilities for handling and directing the work of other employees.

Engineering training is fairly standardized. Men in engineering are more of a particular type than in many other professions. They tend to fit into organized departments. They work well along the lines for which they have been trained. But there is some evidence that many engineers do not adapt well to supervisory work, perhaps because of the exactness of the profession. To help in such situations, we offer some of the basic principles found to be related to successful work relationships.

Personality Problems Mold Employee Attitudes

Stripped of all the office furniture, the sales records, etc., the basic work situation is representative of any life situation. Life has been defined as "a continuous struggle to satisfy ever-changing needs in the face of obstacles or barriers."

In other words, a basic picture of the working life of an individual would show that he is motivated or "fired-up" by basic needs. He works toward certain goals which will satisfy these needs. And along his way toward these goals he meets certain barriers or obstacles which hinder his progress toward these need-satisfying goals.

Most of the barriers that "Mr. Worker" encounters make themselves known through the behavior of other people involved in the work situation. It isn't the typewriter that makes a costly error in typing an order, it's the typist. It isn't "business conditions" that tells the salesman that he doesn't get the order, it's the face to face talk with the customer. It isn't company policy that says he can't go through with a certain idea, it's the immediate boss.

Thus relationships between people in a work situation are very important factors in Mr. Worker's struggle to reach the goals that will satisfy his needs. Actually there are three basic types of relationships between people in the work situation.

1. The relationships between the superior or boss and the subordinate—how the supervisor's actions influence or affect the man underneath him,
2. the relationships between the subordinate employee and the supervisor—how the subordinate employee's actions influence or affect the supervisor, and
3. the relationships between employees on the same work level —relationships between "associates."

Just now we are most interested in supervisory relationships, so we will look at the relationships between you as a supervisor and people working at a level beneath you, and how your actions affect their behavior.

The most outstanding relationship between you in a supervisory role and these folks subordinate to you is their *dependence* upon you for the satisfaction of their needs.

Unless Mr. Worker feels secure in his relationships with you he will look upon your actions with suspicion and view them as a threat to the satisfaction of his needs. Thus you can be seen either as a barrier in his progress toward his goals or you can be seen as a helping hand over the barriers.

A worker must feel *secure* first, before he will be able to work with you cooperatively and before he

can develop into a more valuable employee.

If he doesn't feel secure he will look upon you and management as threats or barriers to his achievement of the goals that will satisfy his needs. We refer to more than just feeling economically secure—we are referring to the feeling of personal security and trust in his relationships with those whose judgments and decisions will directly affect his work stability and work progress.

What can you do to make those who work for you feel secure?

You can do three things to help your people feel secure in their relationships with you and management. These three things are called the "conditions of security."

First, you can provide an *Atmosphere of Approval.* You can make others feel that you respect them as human beings, that you approve of them as individuals, that you are interested in their problems.

You have been in situations where you felt that you had the approval and respect of the person with whom you were dealing. You have also been in situations in which you felt that you had the disapproval of the other person or persons. They acted indifferent to your problems and needs. In which situation did you feel more comfortable and secure?

Unless your people can "feel" this atmosphere of approval they cannot feel secure. They will have no assurance that you will approve of them, even if they "knock themselves out". They will look upon you with suspicion and fear, and won't be cooperative and won't develop to their full capacity.

Second, you can see that your workers possess the *knowledge of what is expected of them.* They need this knowledge to make them feel secure. The life of the worker who lacks this needed information is insecure. It is full of pitfalls. He can at any time through his own lack of knowledge make an error, either of commission or omission, that will interfere with the satisfaction of his needs. In this instance, the old adage that "what you don't know won't hurt you" is false.

What kind of "knowledge" does the worker need to feel secure?

You should see that every employee under your supervision has six different types of knowledge. That's a pretty big order, but if you will study these types carefully you will see why they are important, and how they will prevent unintentional pitfalls:

1. *Knowledge of over-all company policy and management philosophy;* unless an employee knows this he won't know how to gear his over-all thinking and action. If your corporate policy is somewhat conservative, he should know, so that he doesn't unintentionally appear too far out of line. You should pass along your knowledge of company policy to others. Urge them to read editorials in the employee magazine, company advertising and understand relations toward civic affairs.
2. *Knowledge of procedures, rules and regulations;* without this he can learn only by trial and error and will work in fear of pitfalls and possible punishment for innocent mistakes. He should be thoroughly posted on office procedures, rules and regulations.
3. *Knowledge of the requirements of his own job, his duties, his responsibilities and his place in the organization;* unless he knows this he can never be sure when he is to make a decision; and when he is to refer the matter to someone else. Establish a job evaluation program which provides job descriptions for most jobs; the employee is entitled to know what his job consists of and what is expected of him.
4. *Knowledge of the personal peculiarities of his immediate boss;* unless a worker knows something about his own boss he may, again, accidently commit some unpardonable sin. The worker wants to know what the boss never forgives and forgets, what his soft spots are, what he demands of his workers, whether he wants to make all the de-

A supervisor teaches his people to be self reliant. He will not be satisfied with puppets, but will help those who display talent and capacity for growth.

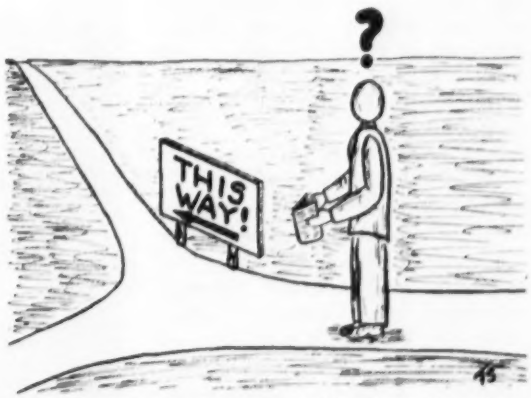


Fig. 5. Good workers do not resent fair, firm, and consistent discipline. They want uniformity of treatment. They will accept discipline which helps them reach their goals.

cisions himself or wants his workers to make some decisions. If you have some pet peeves or some special preferences, those working for you and with you have a right to know about them before they step on your toes and get into "hot water"!

5. *Knowledge of his own work performance;* if he knows where he stands he will know what he must do to be sure that his basic needs will be satisfied—mistakes that he must correct, weaknesses that he must strengthen, strong points that he can use in selling himself. Establish an employee performance rating program. It can be of little value unless the individual being rated knows how and why he is rated as he is. Knowledge of one's own work performance is one of the most important and basic things that an individual must know in order to insure performance on his part that will lead to personal security on the job. Employees appreciate a "heart-to-heart" talk about what they can do to progress.
6. *Knowledge in advance of changes that will affect him;* he cannot feel secure if suddenly things are changed around him—policies, procedures, his own job duties, etc.—he feels disorientated, the paths to his goals are messed up and he has to readjust himself; if he knows changes are coming and if he knows WHY they are coming, he can start to prepare himself for the changes. Too frequent changes breeds insecurity.

The first two conditions needed for feelings of security are, then, an "atmosphere of approval" and "knowledge of what is expected" of a man on the job. The third condition you can provide for your workers which will enable them to feel more secure is *consistent discipline.* Discipline is needed in any work situation in order to make workers feel secure. But discipline means positive support and approval for right actions as well as disapproval and criticism for wrong actions. Such discipline must be consistent—the worker feels more secure if he knows that right actions *always* lead to positive support from his supervisor and that wrong actions *always* means disapproval.

It should be emphasized that consistent discipline can only work in a general "atmosphere of approval" such as was mentioned under the first step toward making people feel secure. A mild form of discipline can be very effective when workers know that their superior respects them and generally approves of them; if they think that he doesn't approve of them, even severe punishment for wrongdoing won't be successful.

Why do workers need constant discipline?

Every worker has, in addition to the big basic needs which fire him on toward his big goals in life, a lot of little needs which aren't always strictly "orthodox" in light of his major goals. At times he's tempted to break the rules in order to satisfy these minor needs and goals even though he knows his action will be somewhat at odds with what he should do to achieve his major goals.

If discipline is consistent—if he knows that observing the rules will lead to approval and infractions will lead to disapproval—self discipline will be easier. It will be easier for him to deny himself these little extra privileges because he is sure that he will be hurting his chances for successful satisfaction of his really important needs. If he isn't sure of consistent discipline, if he knows that sometimes infractions of the rules mean only that he gains additional privileges and loses nothing, he will be tormented by indecisions (note questioon marks on Fig. 5)—he will tend to feel insecure.

These three things, "*atmosphere of approval*", "*knowledge*", and "*consistent discipline*", that you can help provide for your workers will help them to fe*el secure* and enable them to be cooperative and develop their capacities.

Once your people feel secure, there are some other things that you can do to make them grow and develop. As employees grow in usefulness and skill they become less dependent upon their supervisors—they will be able to work along more on their own. This growth and increase in independence is a sign of healthy work adjustment and development—it has been called the search for active independence. This is the type of "independence" good supervisors should want to see develop and grow. There is, however, another type of independence that sometimes develops which isn't so

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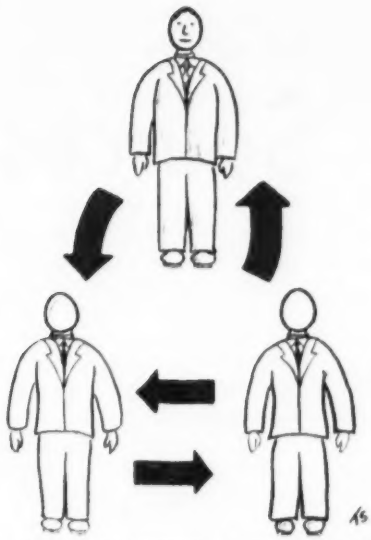
Mr. O. K. Burrows



In work relationships between a supervisor and his employees there are three basic relationships. First, between the supervisor and the man. Second, between the man and the supervisor. Third, between the individual workers at the working level. Their work relations will determine how they react to guidance and instruction both as individuals and as a group.

Fig. 9. A good supervisor helps his people overcome their barriers. He measures the assistance and the job knowledge given to match the capability of the employee.

healthy. It is the type of struggle for independence that results when people feel that they are still just puppets in their supervisors hands. "Puppet" men are dependent upon the "boss"; they can't call their job-soul their own. They soon begin to react against this dependency; they struggle against it and break all the ties that have been established. It is disruptive to any business organization.

The things that you can do to help people grow and become actively independent are:

1. Provide them the *Security* mentioned above,
2. Provide them the opportunity for *Participation*—let them get off of the bench and into the game! Let them pitch or bat; let them participate in the solution of problems and in the discussion of plans and action which may affect them. They will become more aware of your problems and more understanding; they will feel less like "puppets" and more like members of the same team; and they will grow and develop.
3. Provide the opportunity to asume *Responsibility* as they become ready for it—but give it to them gradually. Achieving skill and growth in the job situation is something like perfecting a vaudeville act —balancing on the cycle wheel is similar to establishing initial feelings of security—after that is accomplished one can start juggling additional responsibilities—one or two at a time—until gradually he is able to handle more and more difficult assignments effectively. But if you throw them a lot of responsibilities at once, they can't juggle them — they not only mess up what they can already do, but upset their feelings of basic security as well.
4. Give them the *Right of Appeal* —in every job situation there are bound to be differences of opinion and judgment on the part of different people. If a worker feels that his actions are so dependent upon his supervisor that even when he is positive that his ideas may be more right than the supervisor's, but still he can't see them through, he will feel that he is still just a dependent puppet, and he will revert to a reactive, aggressive type of struggle for independence. (Fig. 9) Here we have a picture of Mr. Worker who has an idea—he is willing to stick his neck out and express his idea—he visualizes certain goals or problem solutions that this idea will provide. His normal course of action is through his supervisor. However, if in his supervisor he meets a brick wall, he feels stymied; he feels dependent; he reacts aggressively. He should be given the chance to ask his immediate supervisor's permission to consult with others. The worker should be given the right of appeal.

Before you can be an effective supervisor and "deal with people" skillfully, you must recognize the basic relationships inherent in every work situation.

You must recognize that every individual in the work situation has basic needs, is struggling for certain goals which will satisfy these needs, and must overcome certain obstacles that get in his way. You must recognize that you as a supervisor are in the position to make or break the subordinate's progress toward the successful accomplishment of his goals. From the subordinate's viewpoint his whole success or failure depends upon the security of his relationships with his supervisor. Unless he feels secure he cannot work with you and his fellow workers in a true cooperative spirit because he will be concerned about his own problems of security and the satisfaction of his own particular needs. Unless he feels secure, he cannot utilize his capacities, cannot progress, cannot develop into a valuable employee who will help you to make the operation of the department or enterprise a big success.

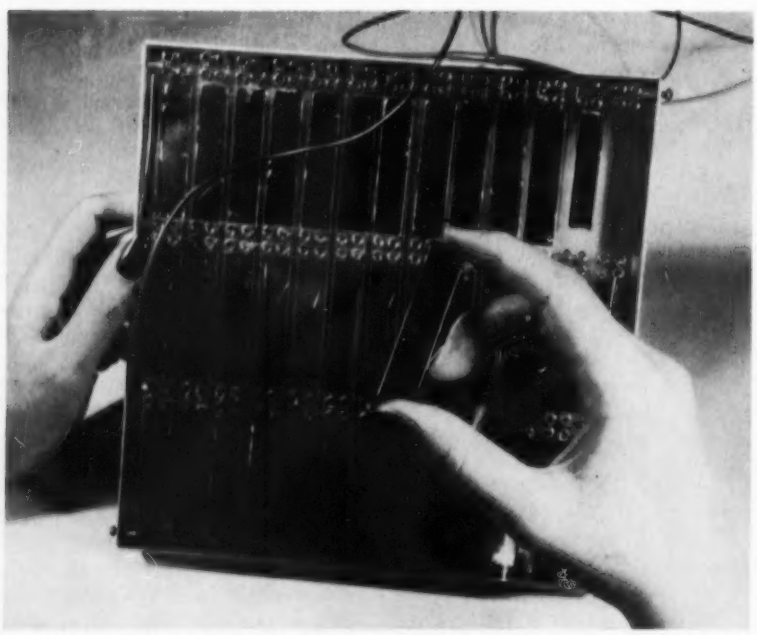
Electric Power Sources

by

SUSAN G. MOORE, EE '59

At 6:00 p.m., on Sunday, April 25, 1954, the following announcement was released to the news services: "A solar battery invented at Bell Telephone Laboratories is the first successful device to convert useful amounts of the sun's energy directly and efficiently into electricity. The battery, composed of strips of specially prepared silicon, has used the sun's rays to power the transmission of voice over telephone wires and to power a transistor radio transmitter . . . The Bell solar battery was invented by a three-member team of Bell Telephone scientists, G. L. Pearson, C. S. Fuller and D. M. Chapin."

This device came as a result of studies of the semi-conductor silicon and its possible applications in modern electronics. The solar battery and other new silicon devices for use in communications were demonstrated at the annual meeting of the National Academy of Sciences in Washington by Bell Telephone Laboratories. The battery, in the form used for the demonstration, achieved an efficiency of six per cent in converting sunlight to electricity, in contrast with the efficiency of other photoelectric devices which is rarely greater than one per cent. The theoretical limit of conversion efficiency in a device of this type is about twenty-two percent. By the end of 1954 the efficiency had been boosted to eight per cent, and it has since been raised even more.



Capable of delivering power from sunlight at the rate of 50 watts per square yard, this battery has silk on strips the size of razor blades.

The device is made of strips of specially prepared silicon, obtained originally from one of the world's most abundant materials—common sand. The strips are wafer thin and about the size of razor blades. The silicon used is first refined to an extremely high degree of purity and then given a little selective impurity of boron and arsenic. These elements are diffused into the silicon wafer to the depth of one-thousandth of an inch, the boron giving positive charges of the arsenic negative charges. It is along this junction that the electrons are "kicked" loose by light rays. The flow of the electrons forced alternately from the positive to the negative side produces a voltage.

Although the solar battery is still in the laboratory stage, it is quite possible that it will be used in the telephone business—perhaps in the capacity of a power supplier for certain types of mobile units or as a battery charger for use at amplifier stations along rural telephone systems. However, the significance of the development of the solar battery lies not in the use to which it will be put, but rather in the fact that scientists have finally discovered a practical means of converting the almost unlimited energy of the

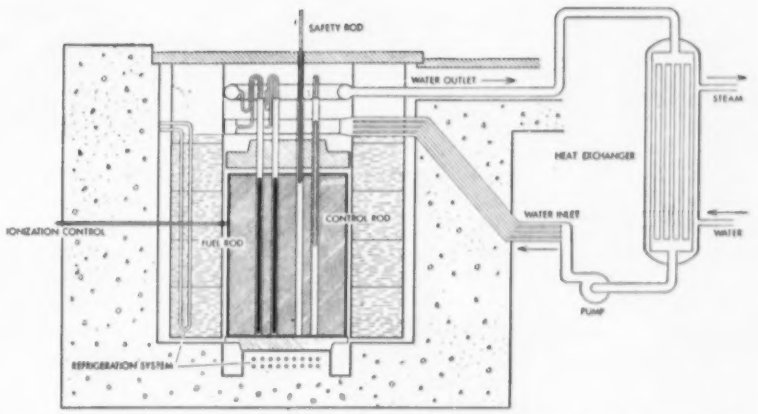
sun into a form useful to mankind —electricity.

Electricity is vitally needed in this technological age, and Man is forever searching for new and better ways to produce it. At present, in the United States, we have over one hundred million kilowatts of generating capacity supplying electricity to our many power systems. These systems supply power to some fifty million customers and include more than one hundred and fifty thousand miles of high voltage transmission lines. In addition, we possess about sixteen million kilowatts of generating capacity installed for self-generating in institutional, industrial, and other power plants, giving the United States a combined total generating capacity of approximately one hundred twenty million kilowatts — more than forty per cent of the world's electric power.

Up until now, the electric power industries have been limited to the use of the so-called "fossil fuels" and falling water as the sources of energy for the production of electricity. However, the fossil fuels will not last forever, and falling water is not available in all areas of the world. Hence, new sources of electric power must be developed in anticipation of that time in the future when coal, oil, and natural gas are no longer available in useful quantities. The solar battery is one possible electric energy source. The atomic battery is another. We also find scientists working on the development of methods of utilizing the heat given off in nuclear reactions, the winds, the internal heat of the earth itself, and the effects of various other natural phenomena. Of these new sources of power, the one which will be tapped first is nuclear reaction heat.

The Atomic Energy Commission has contracted with several private power companies for the construction and maintenance of atomic-powered electric generating stations. One of these plants, located at Shippingport, Pennsylvania, is being constructed jointly by the AEC, the Westinghouse Electric Corporation, and the Duquesne Light Company.

The reactor involved is of the pressurized water type, and, except for this larger size and certain improvements and refinements, incorporates most of the principles of the atomic power plant of the submarine "Nautilus". The core of the reactor, a carbon steel cylinder clad in stainless steel, will be buried deeply underground. It will contain several fuel elements formed of about ten tons of uranium ore that has been enriched with the radioactive isotope U-235. The dimensions of the container specify an internal diameter of six feet and a height of twenty-five. Four "loops", or heat exchangers, together with their pumps, steam generators, shut-off valves, and interconnecting pipes will come from this reactor. Water, with a temperature near six hundred thirty degrees Fahrenheit and under a pressure of two thousand pounds per square inch, will be sent through the reactor to the heat exchangers. The steam generated will then be piped to an adjoining building where it will be put to work driving the turbines that operate the electric generators.



Pressurized water reactor furnishes energy for the 5,000-kilowatt atomic power station of the U.S.S.R. Academy of Sciences. Heat of fission in its lattice of uranium rods and graphite is absorbed by circulating distilled water, which is kept under a pressure of 1,500 pounds per square inch. Pressure raises the boiling point of water and enables it to absorb more heat. The heat exchanger reduces the temperature of the water from about 270 to 190 degrees centigrade, thereby extracting the energy for generating electric power. The Soviet Union announced that it plans to construct a 100,000-kilowatt version of this type of reactor.

The Shippingport reactor is not, however, the only type of reactor that can be used in the generation of electricity. The AEC proposes to encourage the development of four other distinct types besides the pressurized water reactor—namely, the homogeneous reactor, and the fast breeder recactor, the boiling water reactor, and the sodium graphite reactor. The general concensus of opinion is that the homogeneous reactor is most promising for achievement of economically competitive atomic power, while the pressurized water reactor is least promising.

In connection with the development of the homogeneous reactor— one containing fuel in a water solution— the AEC is planning two projects. The first would be a slight scale-up of the small homogeneous reactor experiment at Oak Ridge, from which they hope to gain information on corrosion, chemical processing, and operation conditions that is not now available. The second project would involve the construction of a larger homogeneous reactor that would produce sixty-five thousand kilowatts of heat and breed U-235 in a thorium blanket surrounding the core of the reactor.

A breeder reactor — one which also produces or "breeds" new fissionable material—of intermediate size is also planned. This will be a scale-up from one hundred seventy to fifteen thousand kilowatts of electric power, with the temperature and stream pressure increased to values appropriate to a full-scale power breeder reactor. Auxiliaries, such as heat exchangers, valves, and pumps, will also be of

sizes suitable to a full-scale reactor.

Next on the program will be a boiling water reactor—one which explores the concept of boiling water in a reactor to create steam directly for a turbine—with an output of five thousand kilowatts of electricity. This reactor will be based on an experiment performed at the Testing Station in the summer of 1954.

Finally we come to the plans for a reactor that would combine sodium as a coolant and graphite as a moderator. This would give us the advantage of high temperature without high pressure. The AEC has decided to go ahead with a sodium graphite reactor designed to produce about twenty thousand kilowatts of heat but without any equipment attached to convert the heat to electricity. North American Aviation, Incorporated, has been making extensive investigations along these lines for the AEC.

At present, nuclear power, however unlimited it may seem, is still not economically competitive with present power sources, even though atomic fuel costs for power generation are competitive with coal. In fact, atomic fuel is from a third to a half cheaper. The problem lies in the capital investment necessary for power plant construction. Steam power plants cost approximately two hundred dollars per kilowatt hour. The lowest figures for atomic power plants run between three and four hundred dollars per kilowatt hour—and this is just on paper. The atomic power plant at Shippingport, Pennsylvania, is expected to cost many times more than this.

However, all these proposals for large-scale power generation from the fission of uranium in a reactor are based on indirect methods. The heat energy created by fission is used to produce steam, which drives a turbine. This turbine, in turn, drives a conventional generator. Scientists at the Radio Corporation of America laboratories have developed a method of converting nuclear energy into electrical energy directly. The announcement of the development of the atomic battery came in January, 1954. At that time, Dr. E. W. Engstrom, Executive Vice President in Charge, RCA Laboratories Division, commented that "Hitherto, power from the atom has been used in much the same way as coal in the furnace of an electric power plant. All the remainder of the plant remained unchanged—boilers, and an engine or turbine driving a massive electric generator. Only the nature of the fuel was altered when nuclear energy replaced coal or oil."

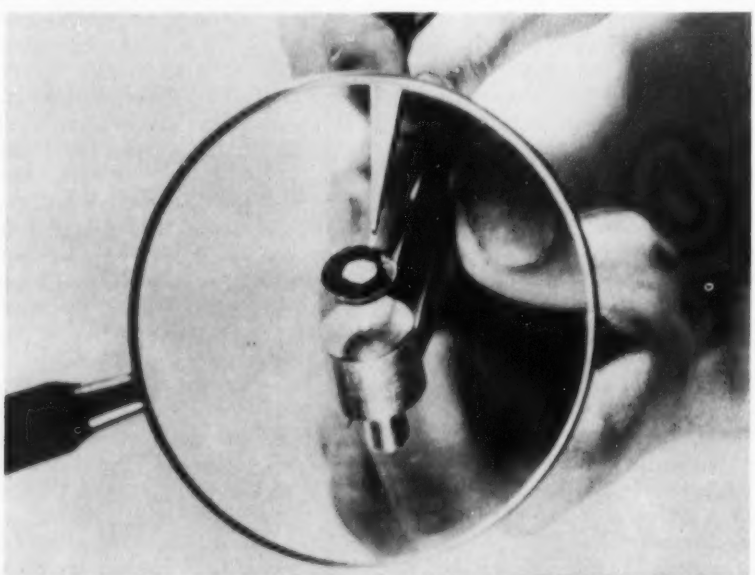
Dr. Engstrom pointed out that if the atomic battery fulfills its promise on a large scale, engines, boilers, and electric generators will become things of the past. He called attention to the fact that atomic generators could be installed at or near the place where power is to be used, thus eliminating the necessity for the costly process of distributing power over long distances. These batteries, he said, "would be designed as 'on-the-spot' energy sources for specific installations, whether a radio beacon or a individual home. Naturally," Dr. Engstrom continued, "much fundamental work and applied research remains to be done and many years will elapse before such a goal is attained."

This atomic battery consists of a wafer of a semi-conducting crystal coupled to a radioactive source. An impurity material is alloyed into the crystal to form a junction similar electrically to those used in certain types of transistors, but considerably larger, having an area of one twentieth of a square inch. The radioactive material used is strontium-90, a highly active source of beta particles. This is one of the most abundant of the materials resulting from the fission of uranium in a reactor and has a half-life of roughly twenty years.

In the battery, one three-hundredth of a cubic centimeter of the radioactive strontium is spread in a thin layer against the junction wafer. The semi-conducting crystal wafer is bombarded with several billion electrons per second from the strontium. As these electrons penetrate the wafer, they release an average of two hundred thousand electrons for each bombarding electron. These released electrons flow across the junction of the wafer and produce a voltage which can be applied to an electronic circuit and cause a current. The electron action within the crystal wafer, known as the electro-voltaic effect, is a phenomenon of solid-state physics which had not yet been put to any practical use.

The prospects for practical application of the atomic battery are good. At the time it was announced, Brig. General David Sarnoff, Chairman of the Board of the Radio Corporation of America, said: "Although it is still too soon to know

(Continued on page 42)



Magnified model of the two basic elements of experimental RCA Atomic Battery, which by means of a new method makes it possible to convert atomic energy directly and simply into small but useable quantities of electrical energy. Cylinder (at right) has thin coating of radioactive material on its face which is placed next to transistor-like wafer. Radiated electrons bombard wafer and release many more electrons which provide battery's current and voltage.

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Designing for Efficient Use and Comfortable Operation

by RICHARD S. BARRETT

Vice President, Personnel Research and Development Corporation

Reprinted from Cleveland Engineering, January 5, 1956

In recent years you have no doubt noticed in the engineering publications and in your own work the term "human engineer." It's a funny word. It seems to imply that other engineers aren't human. But, it has stuck, and rather than try to develop a new word let's define the old one. The human engineer is interested in combining and optimizing the two essential elements that are involved in the design and use of equipment. First, he designs it so that it will perform the function for which it is designed. This is an engineering problem. Second, he designs it so that it can be best used by the human operator who controls it. *This is a human problem.*

Calculator keyboards are neater, computational errors are reduced, and the keys have a more pleasant touch. The operators of some large strip mining and drag lines now work in air-conditioned comfort, manipulate controls patterned after the airplane joy stick and communicate by radio with crews who work with them. Complex electronic control panels are redesigned for ease, speed, and accuracy of operation. These changes and many like them are indicative of the current trend toward considering the operator as well as the engineering requirements of the equipment. In order to explain what a human engineer does I will avoid the more specialized problems and make up a hypothetical project of redesigning a kitchen range. I will use as a model my wife's kitchen range, partially because I am familiar with it and partially because it could use some redesigning by a human engineer.

The kitchen range will serve as an admirable model because it is well known and because it is a relatively complex piece of equipment which is used by a great many people. However, in addition to the kitchen range, I will add a few examples from other fields because some of the problems the human engineer must meet in one situation do not appear in another.

Let us suppose that the human engineer has been employed by a manufacturer who is only too well aware of the highly competitive nature of his business and he feels that the advantage that can be gained by making his range more easily operated may well mean the

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Richard S. Barrett

difference between moderate and substantial profits. He has in his wisdom given the human engineer free rein in the redesign of the stove. The human engineer, however, is well aware that costs must be kept to a minimum or else the work will never be accepted. So, to minimize the costs and to maximize the value for the range manufacturer he outlines a program and then follows it through.

The manufacturer of the ranges has told our human engineer that he wants the range redesigned to make it a more attractive item for the use of the housewife, and the human engineer explores the problem thoroughly before going ahead. What, for instance, is the expected price range for the finished range? We could plan a beautiful range that would cost so much that no one would buy it, and at the same time we could design a range so cheaply that it wouldn't be any improvement over the current ranges. Furthermore, the company has a large investment in special equipment and in the training of the personnel, and drastic changes in the range may not be as welcome as the manufacturer indicated in the beginning. Therefore, this area is thoroughly explored and the limits of the kinds of changes that can be made are established. Let us say then that the manufacturer is contemplating redoing his whole line of ranges and he is willing to work on them from the inside out to improve their desirability. But, if it is possible to use any of the old components without interfering with the design, he is of course anxious to do so.

One of the objectives of the study has been established and the limits of cost, redesigning, and retooling have been set; the human engineer is then prepared to undertake his first step. He asks "What is the range used for?" Obviously the answer is "to cook on." True, but how much cooking is done in utensils on top of the range, how much baking, how much roasting? Just what are the requirements that a cook has for a satisfactory range? It's a lot of fun to speculate about such a question but there's only one way to get an answer. That is to go out and find out what housewives do.

Model kitchen in Cornell's Home Economics School *typifies design in terms of human* engineering.

Our human engineer would first select a sample of housewives, say 25 of the type of people who would be expected to buy a range in the price class of the one which he is redesigning.

He watches the housewife with a critical eye and make voluminous notes as to what she does. He tries to record everything which may be pertinent because he can't tell at the beginning what is going to turn up to be important in the end. Some things will be obvious. She puts pots on the top of the range, turns the heat on, and lets them boil. She reheats the oven, puts in a roast, browns the roast, cools the oven down a little bit and then lets it cook. He notices, for instance, that whenever she touches the roasting pan she uses a pot holder or an insulated mitten but there is no place on the stove for storing these useful items, so he makes a note. "Make a provision for keeping pot holders and insulated mittens handy" and may eventually recommend that a clip be mounted on the front of the stove to hang these items on.

This procedure is the same as would be carried out for the redesign of any piece of equipment. The first step is to find out what the equipment is used for regardless of whether it is a turret lathe, an electronic computer or an adding machine keyboard. The process of finding out what the equipment does is a lengthy one and not to be passed off lightly. It involves really two operations, first, to learn what is being done as in the case of the range prospect; second, to unlearn the things that are being done wrong.

The first and simplest area which then comes under the consideration of the human engineer is size and shape of people, how hard they can push or pull, how finely they can adjust a knob. A great deal of information has been gathered in this area and it is readily available to the human engineer. You have no doubt seen such information in use. The semi-circular bins which are placed on the bench in front of the small assembly worker are an example. You know of course that the least used items are placed farthest away and a space in the center is reserved for the assembly operation itself. Similarly the height of a chair, the amount of space a person needs to pass another person in a corridor and so forth have

all been worked out and are used in the human engineering problems.

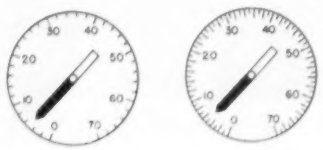
Let's examine our typical range from the point of view of the physical dimensions. The counter height is comfortable. It is neither too high nor to low for convenient usage. The control knobs are placed so they can be easily located and used. There is a light on the range so that if the kitchen is poorly illuminated at least the range surface will be under a bright light when the range is in use. As far as the size of the range in relation to the size and strength of the housewife are concerned, it is more than adequate.

In the use of almost all equipment the operator must obtain some information from the object either by looking at it, listening to it, or touching it. Our range of which I am speaking has several dials. Those which operate the heating elements on top of the range are labeled high, medium high, medium low, and simmer. These words appear in small black lettering on a white background and can be read if the housewife looks carefully at them. There is a clock which has a large enough hand and dial so that the time can be read.

In these respects the range is very much like most equipment. We have had enough experience with dials and indicators to make them big enough and contrasty enough with their background so they can be read. Sometimes, however, in actual use the lettering or numbering may be obscured by dirt or grease. In the development of different kinds of equipment provisions should be made to avoid the obscuration of information in the following way.

It is not enough to see the lettering or the indicators. The person must be able to see them easily and to interpret what they say accurately and quickly. Now you would think that if one could see the dial that he could read it and interpret it. But, surprisingly enough, this is not the case. For instance, on the range under consideration the words indicating the temperature of the heating elements is clear and readable but they are hard to perceive at a glance because the letters are rather small and the words do not stand out. It would be much easier to determine the amount of heat being given off by an element if the associated switch were marked with a series of red dashes, a long dash for the highest heat and just a short dash for the simmer and intermediate sized dashes for the different temperatures. Thus, by a quick glance at the switch the housewife could tell just what the temperature was.

The same sort of reasoning is true for all kinds of equipment. It is not enough to see or hear what you need to know but you must be able to understand it quickly, easily, and accurately. For instance, which of the two dials below would be most easily and accurately read?



Research has shown that the dial with the fewer lines, strangely enough, leads to quicker and more accurate reading.

It is not enough to be able to perceive what you see but the equipment must be designed to give the information that is required. Some pieces of equipment give over-information. For instance, the pilot's cockpit has so many dials and gadgets and indicators that the pilot cannot watch them all and he does use the information that is available. He would be better off in many cases if he had fewer displays and gadgets to work with.

The range that I am describing highlights a different problem, that of ambiguous information. When the housewife turns on the oven, a light comes on which indicates that current is flowing through the heating coils. When the oven comes up to the temperature set on the dial the thermostat turns off the current temporarily from the coils and at the same time the light goes out. When the oven has cooled off a little bit, the current again is switched on to the coils by the thermostat and the light is once again lighted. This is very handy because when the range is first turned on the housewife may glance at it from time to time and when the light goes out she knows that it is up to temperature. But let's look at the information that these lights convey:

Light on: Oven switch is on, thermostat switches on.

Light off: Oven switch is off, oven is not in operation. Oven switch is on but thermostat switch is off.

Our light conveys ambiguous information. After the housewife has taken the roast out of the oven she may later glance at the light to see whether the range is on or off. If the light happens to be off due solely to the fact that the thermostat is off, she will unwittingly leave the range on with possible disastrous results to the roasting pan left in the oven.

This ambiguity of information which the range presents highlights a procedure in the use of human engineering which I mentioned before. That is, one must very carefully determine what the user of a piece of equipment does, what information they need, and what they will do on the basis of certain information. Only by careful study of the purpose of the equipment and the way people use it can the equipment be designed to give the information which is desired.

Human engineering concerns itself with problems which go beyond that which can be illustrated by the example of a range. Human engineering can be used in situations where complex information has to be collected, perceived, understood, and some important decision made. Human engineering can be brought to bear in this situation by helping to present the information in such a way that the person who must make the decision gets the essential information without the confusing details.

In this article I have tried to give some insight into the activities of the human engineer by using the homely example of the range. What has been said about the range can be true about any consumer product. In addition, human engineering may be important to your own plant operations in order to make them more efficient and safer.

A Many of the coming developments at Martin lie in areas still so unexplored that little experience even exists.

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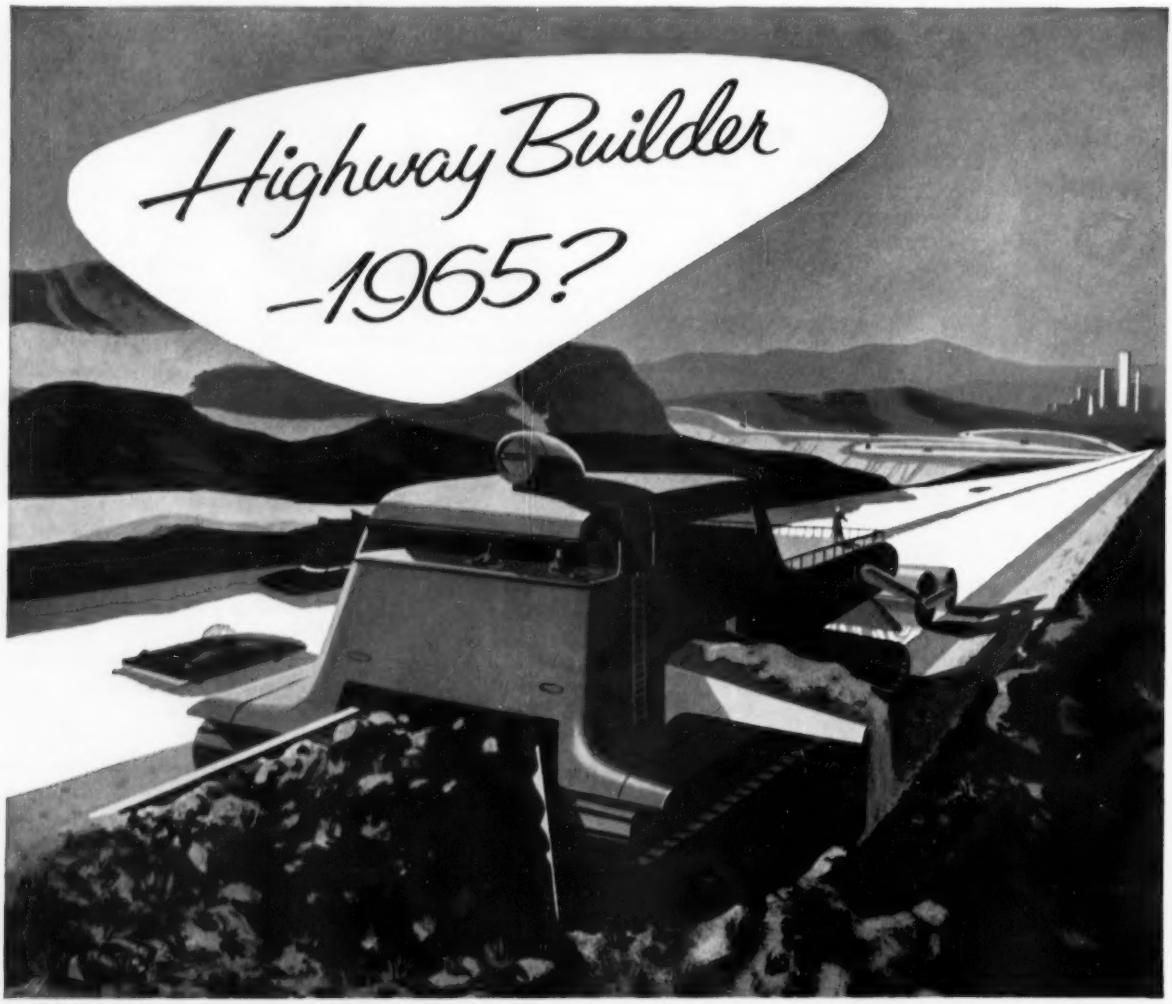

TOMORROW: A ribbon of paving unreels as this road-builder of the future turns open country into superhighway.

TODAY: New Departure ball bearings are used in power shovels, trucks and similar heavy-duty equipment, because they require no special attention and virtually no maintenance. Frequently they outlast the machine itself.

What a simple matter road building would be if it were reduced to a single machine that **levels, grades and paves** . . . all in continuous operations.

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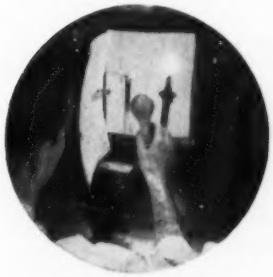
Some Examples of Sylvania's Engineering Diversification



LIGHTING: Testing bulb light transmittance photometrically

RADIO: Subminiature tubes designed & developed at Sylvania

ELECTRONICS: Testing the characteristic of a counter tube

TELEVISION: Color screen inspection, microscope & ultra-violet light

ATOMIC ENERGY & RESEARCH: Compacting powders on new presses

What College Seniors Want Most They Get as Sylvania Engineers

Everyone knows that engineers are men with minds of their own. But when it comes to what they want in a job, they're in solid agreement (according to a recent engineering college survey). And what they want bears a marked resemblance to what they find at Sylvania.

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SYLVANIA OFFERS: Sylvania believes you learn by doing – not by looking over someone else's shoulder or being bogged down in routine details. And so, engineering there is what you hoped it would be: You work on a project and see it through; your assignments are varied; and you're given responsibilities sooner than even you anticipate.

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SYLVANIA OFFERS: Sylvania's operations span the fastest-growing, most dynamic fields in American industry today. Products ranging from color television tubes to atomic reactor fuels... from powdered metals to advanced missile systems and microwave devices... from semi-conductors to photo-flash and Softlight bulbs, and many others... constantly present you with new problems, new challenges.

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Brain Teasers

Here are four problems for you to solve. Send in your solutions early, and you may be the lucky winner of $3.

1. If two locomotives start from two cities 132 miles apart headed toward each other on the same track, and if a fly flies back-and-forth between the headlights of the two trains as they speed to their own (and the fly's) destruction, how many miles will the fly fly before he is crushed to death between the two headlights? One locomotive travels at a constant speed of 83 miles per hour; the other at 37 miles per hour. The fly does 7 miles per hour.

2. A boat is carrying cement blocks in a small pond. It capsizes and the blocks drop to the bottom of the pond. The boat is righted and emptied of water. The question is: Will the level of the pond rise or drop because of the blocks on the bottom?

3. Rufus T. Flywheel leaves his house each morning by car for the two-mile drive to school. Being a very precise individual, he knows that he must average 30 mph to arrive on time. One infamous morning, an ailing trolley car impeded Rufe's progress for the first mile, so that his average was only 15 mph for that mile. He quickly calculated the proper speed for the remainder of his trip so that his punctual record would be unbroken. What was Rufus's correct conclusion?

4. Three women together buy a ball of silk six inches in diameter. How much of the diameter must each wind off to get her third?

CORNELL ENGINEER SCHOLARSHIP

A second or third term EE will be the recipient of a $150 scholarship to be awarded this spring by the scholarship committee of the School of Electrical Engineering. The award, donated by the staff of the Cornell Engineer, is made annually on the basis of scholarship, extra-curricular activities and financial need, and is rotated among the different engineering schools from year to year.

Application should be made to the office of the Director of the School of Electrical Engineering.

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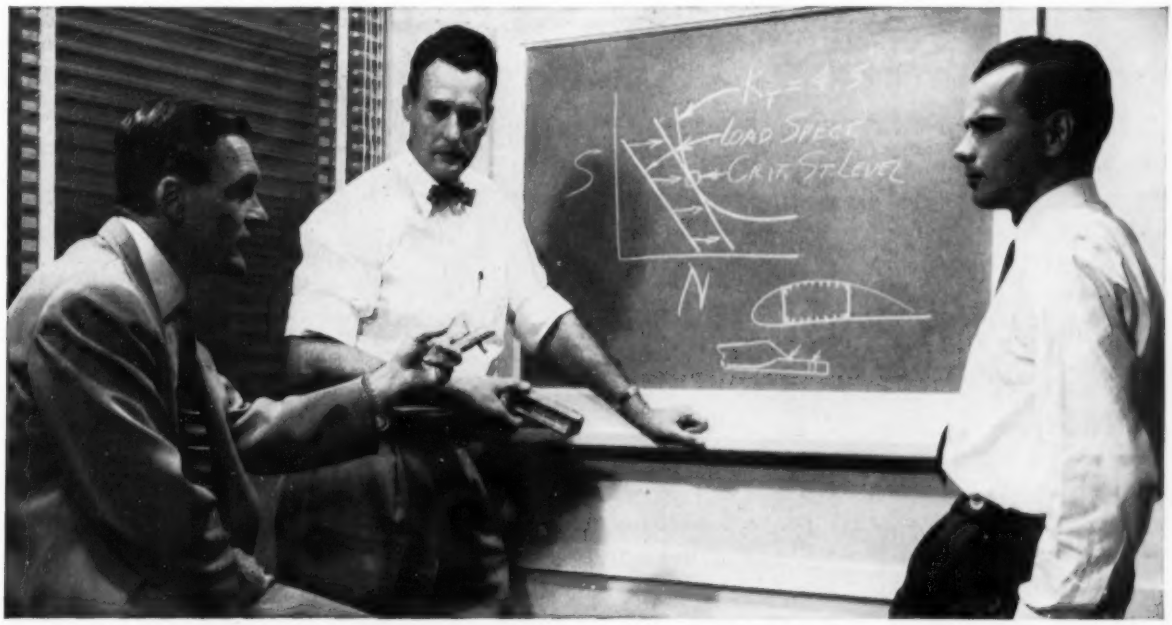
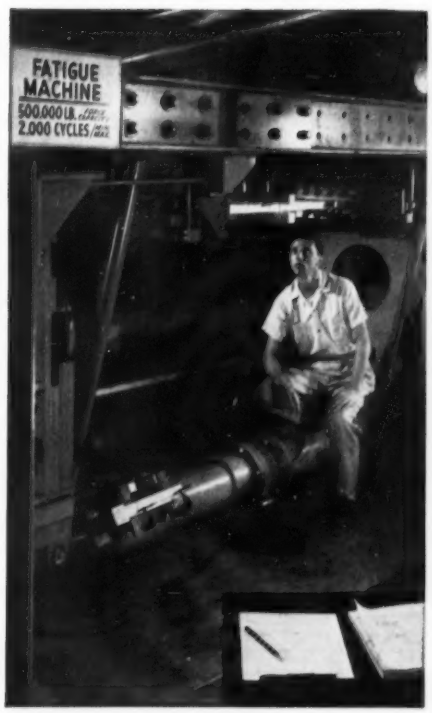


J. F. McBrearty, chief structures engineer (left) discusses fatigue test program of integrally-stiffened wing lower surface structure of a new transport with E. H. Spaulding, structures division engineer and J. G. Leewolt, stress engineer. Lockheed's 500,000 lb. Force Fatigue Machine was used in test program.

Advanced structures facilities speed careers of Lockheed Engineers



Ralph Oliva, research engineer, examines Super Constellation skin for signs of fatigue failure.

Engineers in Lockheed's Structures Division are supported by unmatched research and testing facilities in their constant effort to increase strength while decreasing weight.

Among those facilities are the Lockheed-designed 500,000 Lb. Force Fatigue Machine, first of its size; Shimmy Tower, only one in private industry; and Drop Test Tower, largest in the nation.

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DOW PROFILE NO. 1—RALPH PFISTER

DOW

RALPH PFISTER'S FAST RISE in only four years at Dow exemplifies the opportunities that exist with the "fastest-growing chemical company."

"Expansion is so rapid at Dow, you have to keep moving up, growing, learning, just to keep pace."

Thus, this 27-year-old production engineer explains his new position as Superintendent of a multimillion dollar warehouse with a work force of 100 men.

In June, 1951, Ralph Pfister graduated from Northwestern University's Technological Institute. His studies, experience and natural inclination pointed to a future in production engineering. Pointed right to a position as process engineer in the Dow saran plant.

Within three years, Ralph moved to Ass't. Superintendent of a production train in a wing of the Styron® plant, to Ass't. Superintendent of the entire wing and two months ago to Superintendent of the 500,000 sq. ft. warehouse serving all wings of the plant.

"Always something new to learn . . . upper management not only allows but encourages our making the important decisions . . . the people are interesting, stimulating both at work and socially."

These excerpts from a conversation with Ralph Pfister give a quick profile of employment at Dow. Here is the fastest-growing company in the nation's fastest-growing industry. Dow communities provide some of America's most pleasant living surroundings and educational and recreational facilities.

THIS COMMUNITY CENTER in a Dow city is typical of the excellent recreational facilities available to Ralph Pfister and other Dow employees.

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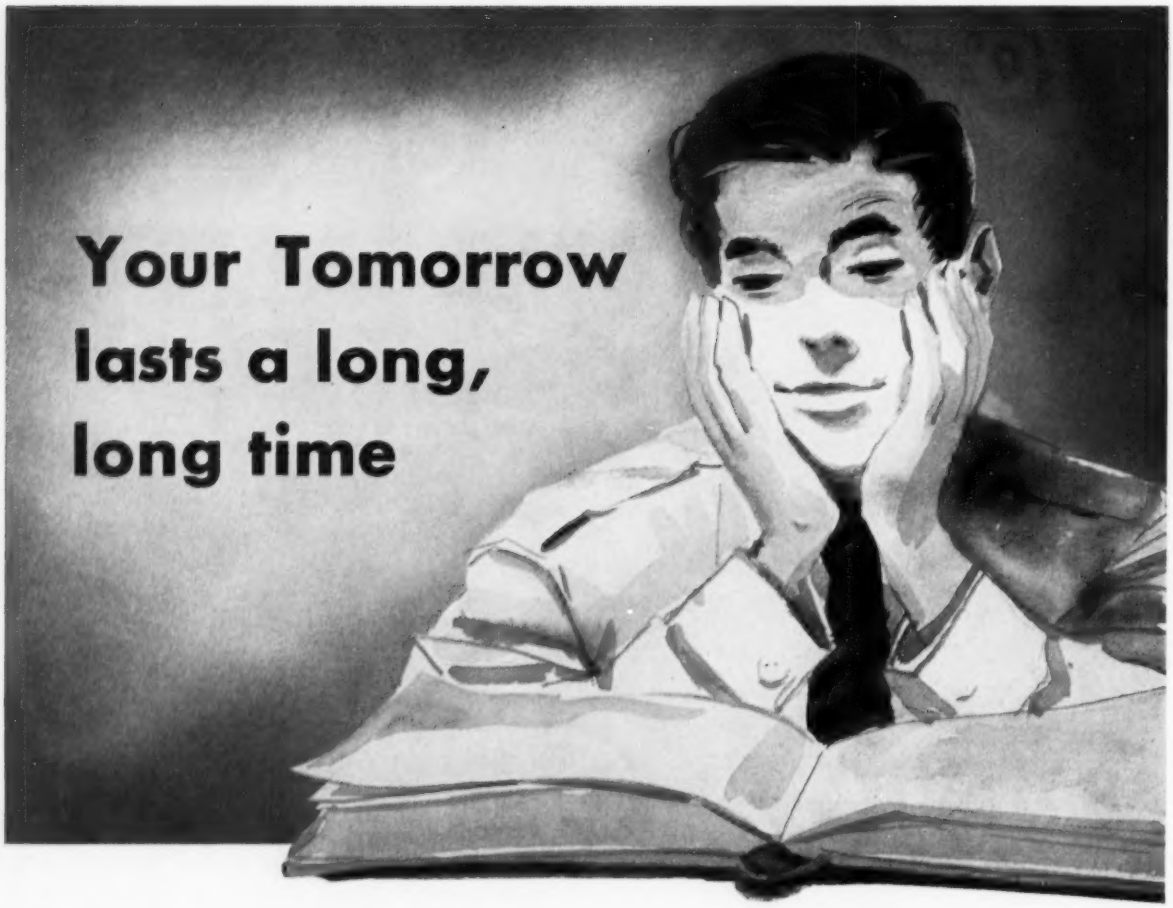

THE Tomorrow which you are planning Today lasts a long, long time—and it can be a wonderful future from the very first day in the right job. As an engineer for a Pennsylvania Electric Utility Company you'll find a future full of challenge—full of opportunity—in a stable and progressive industry that *must* supply the life blood of our economy. Modern living demands and relies on the ever-present supply of economical power.

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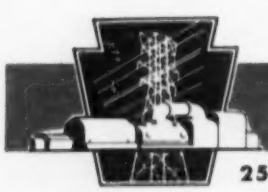

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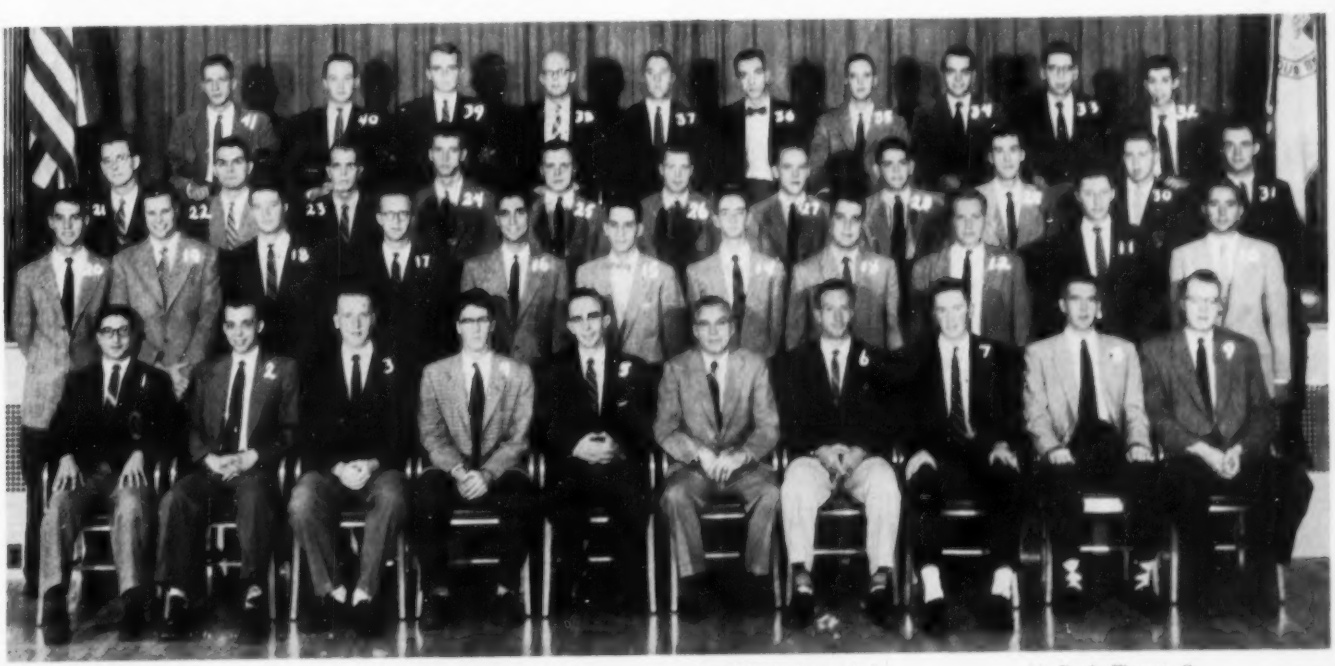

1. Bahary, Emil S.
2. Long, Robert A.
3. Tillman, Alfred J.
4. Johnson, John R., Jr.
5. Bernhard, Richard H.
6. Spindler, Alan H.
7. Reusswig, Theodore F.
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13. Klotz, Paul Rausch, Jr.
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15. Fromm, Gary
16. Kopal, Donald H.
17. Hopkins, Robert H.
18. Shriver, Richard H.
19. Montague, L. David
20. Wolcott, John N.
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22. Keller, Otis A.
23. Goldgraben, J. Richard
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25. Dunlap, Errett, III
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27. Howard, C. Frisbie
28. Minsker, Eliot A.
29. Koch, Edward B.
30. Liedell, James E.
31. Reed, Thomas C.
32. Manning, Stanley A.
33. Brown, Leonard D.
34. Stewart, James B.
35. Landback, Richard E.
36. Simson, Bruce R.
37. Cody, Winthrop B.
38. Forbes, William R.
39. Schulter, Peter M.
40. Wanvig, Thomas W.
41. Beachley, Norman H.

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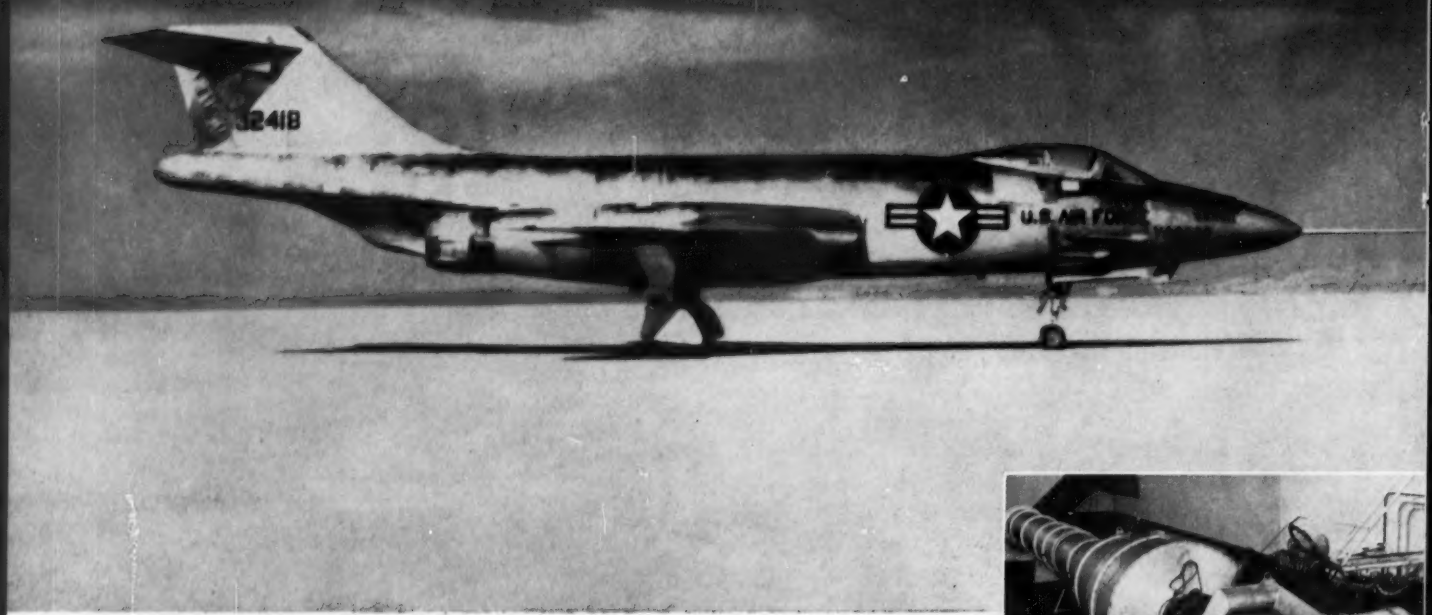

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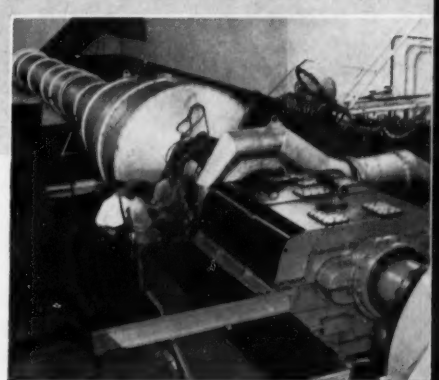


MECHANICAL ENGINEERS are concerned with many phases including experimental testing and development, mechanical design, stress and vibration analysis, combustion research, heat transfer and nuclear reactor development.

AERONAUTICAL ENGINEERS work on innumerable internal and external airflow problems concerned with design, development and testing of aircraft powerplants. Some who specialize in analytical engineering forecast engine-airplane combinations a decade in advance of design.

ELECTRICAL ENGINEERS directly contribute their specialized skills to the analysis and development of controls, systems and special instrumentation. An example is the "Plotto-mat" which automatically integrates and plots pressures, temperatures and air angles in performance testing.

...ills to create the top aircraft engines

An aircraft powerplant is such a complex machine that its design and development require the greatest variety of engineering skills. Pratt & Whitney Aircraft's engineering team has consistently produced the world's best aircraft engines.

The best planes are always designed around the best engines. Eight of the most important new military planes are powered by Pratt & Whitney Aircraft J-57 turbojets. The first two jet transports in the United States will use J-57s. Further, no less than 76 percent of the world's commercial air transports are powered by other Pratt & Whitney Aircraft powerplants.

Such an enviable record can only be built on a policy which encourages, recognizes and rewards individual engineering achievement.

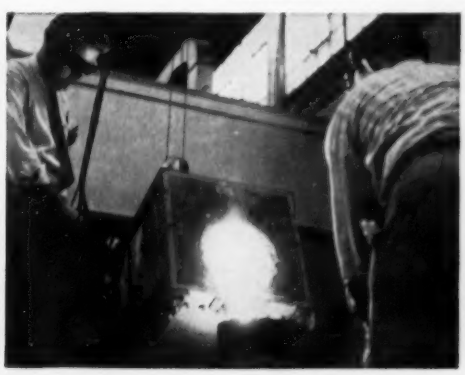
PRATT & WHITNEY AIRCRAFT

Division of United Aircraft Corporation

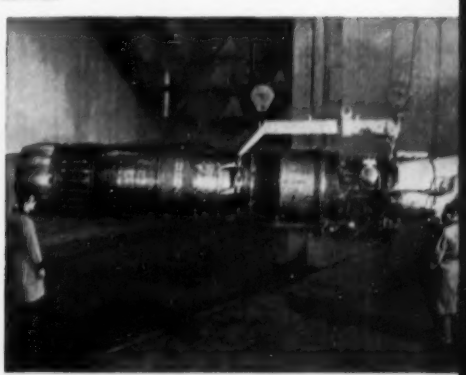
EAST HARTFORD 8, CONNECTICUT

World's foremost designer and builder of aircraft engines

CHEMICAL ENGINEERS, too, play an important role. They investigate the chemical aspects of heat-producing and heat-transferring materials. This includes the determination of phase and equilibrium diagrams and extensive analytical studies.



METALLURGISTS investigate and develop high temperature materials to provide greater strength at elevated temperatures and higher strength-weight ratios. Development of superior materials with greater corrosion resistance is of major importance, especially in nuclear reactors.



WORLD'S MOST POWERFUL production aircraft engine. This J-57 turbojet is in the 10,000-pound thrust class with considerably more power with afterburner.

CORNELL SOCIETY OF ENGINEERS

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William M. Leonard

"The objects of this Society are to promote the welfare of the College of Engineering at Cornell University, its graduates, and former students and to establish closer relationship between the college and the alumni."

One of this country's favorite indoor sports is kicking the conversational ball around on the subject of the good old days. You know how the game goes.

Good fellows get together and each in turn tries to out do the others in recalling and relating almost forgotten incidents that took place when the same crowd, years younger, were together—such as when they were on a week-end pass in Paris, sitting in the cold and rain at some famous football game or working together as cadets in some engineering drafting room. It's grand and glorious and good for the soul.

Sooner or later, the nostalgic raconteurs get around to the good times, and some of the bum ones, they had at college. In time and inevitably, the session breaks up on a note of sadness and one of the gang will put it into words. "Those were the happy days . . . wish I were back in school and live them all over again."

And there are, of course, the precious personal thoughts when one is alone. The memories of bygone days that come to us in quiet moments, of pleasures and moods and experiences—and the friendships—we knew and savored during our years at school. The slow walk across the Quadrangle with the trees showing their new Spring green, that thrill of sitting 'way high up at Schoellkopf Stadium waiting for the gun to start the game far down on the field below. The tingle the day you wondered whether to ask that coed if she'd like to stroll along the wooded paths along Beebe Lake. In such precious and reflective moments, you just can't help wishing you could recapture the satisfactions of those college days.

Yet, obviously, we can't spend all our lives in a classroom or on a campus. There is a livelihood to be made and each of us reaches that thrilling and important day on which, with mixed emotions, we accept the sheepskin, pack our bags and move out of the dormitory or the fraternity house to take our places as laborers in the vineyard.

Certainly, on that day at least, each of us feels that, suddenly and irrevocably, we walk from one world to another and feel that the new life severs our participation in the old.

Regrettably, this does become true of a few alumni and, to a lesser degree, for a great many more whose once-strong reluctance to say farewell is tempered by occasional attendance at a class reunion.

But let us take the long view. After all, Cornell is not just so many acres with its many noble buildings, broad lawns and tall trees on the shores of Lake Cayuga, Cornell is a world-wide community, hedged in by no campus boundaries or a calendar of enrolled years. As a Cornellian the choice is yours to exercise your privileges of membership and enjoy its rewards or to let it all slide back into the past.

It would seem to me that, to keep your franchise alive, you should at least join your local Cornell Club where you will keep alive an active companionship with other men who have shared your collegiate background.

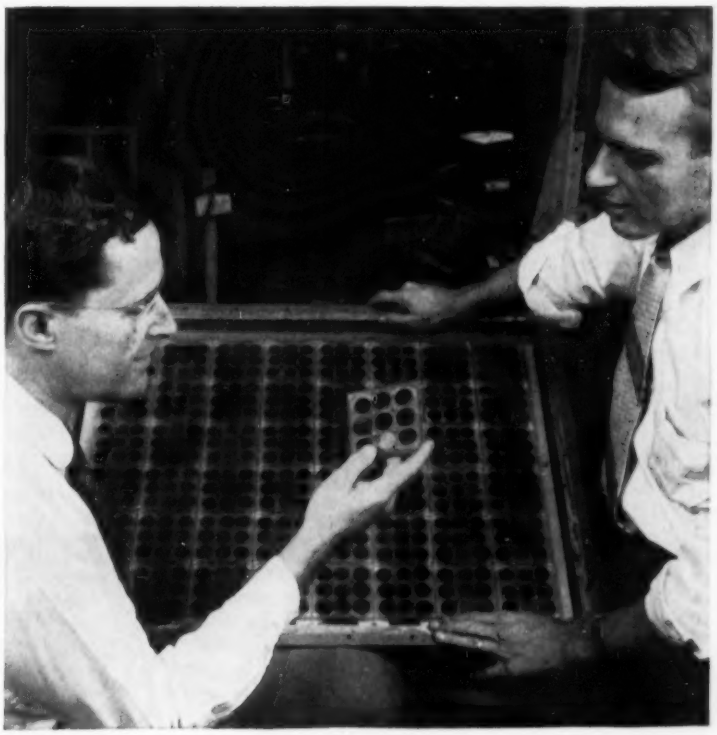
Far better, to my view, is to join in the work of the Secondary School Committee and in so doing contribute to the essential and constant refreshing of Cornell's greatest and most enduring asset, its reason for being—the student body.

If you do, I assure you, when Committee activity brings you back to Ithaca, you will not come as the traditional and time-worn Old Grad, the man who once belonged. You will walk proudly across the Quadrangle as becomes a man who is as much a living part of the University as you were in "those good old days" when you lived and studied in sight of the Sibley Dome.

W. M. Leonard
President Cornell Society of Engineers

How the Bell Solar Battery Converts Sunlight into Electricity

Another example of the pioneering opportunities for engineers at Bell Telephone Laboratories



In a career with Bell Telephone Laboratories, young engineers and scientists can expect to take part in pioneering radically new developments in the field of communications. One such development is the Bell Solar Battery.

Like the transistor, the Bell Solar Battery was invented by Bell System scientists. Indeed, it was the study of semiconductors which revealed the fact that sunlight could induce the movement of electrons in silicon and thus create electric current.

The basic unit of the Bell Solar Battery is a thin disc compounded of two kinds of treated silicon. The body of the disc is silicon with a trace of arsenic to provide negative potential. Into this body boron is diffused, to a depth of less than 1/10,000 of an inch, providing positive potential. The junction of these layers of treated silicon is the "*p-n*" junction. Equilibrium between the *p* and *n* regions is upset when the disc is exposed to sunlight, which jolts electrons free, and causes them to move across the *p-n* junction. The charges pass through contacts, and current — though a small amount — flows.

In the past year, the efficiency of the Bell Solar Battery has been increased from 6 to 11%. Right now, in Americus, Georgia, the battery is being used experimentally to power a rural telephone system. And more widespread application is in the offing.

The Bell Solar Battery is one of many developments underway in the Bell System to improve America's telephone service. The special role of Bell Telephone Laboratories in forwarding the exciting search for tomorrow's better telephone service is creating many fine career opportunities for young scientists and engineers. Your placement officer can give you more information about careers with Bell Telephone Laboratories, and also with Bell Telephone Operating Companies, Western Electric and Sandia Corporation.

The Bell Solar Battery consists of 432 silicon discs wired together. It is mounted on telephone poles to catch prevailing sunlight, and on a sunny day can produce 10 watts. Excess energy is fed into storage batteries, to be used at night or in bad weather.

BELL TELEPHONE SYSTEM

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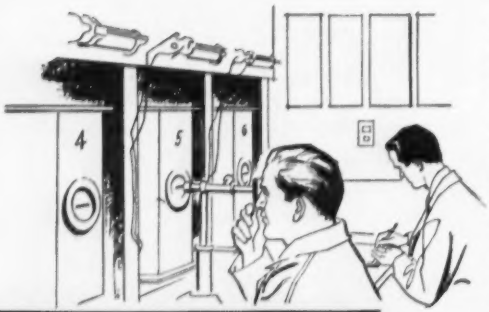
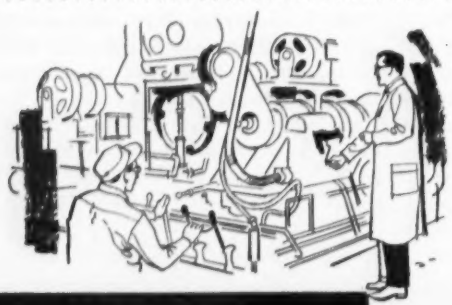


IN TITANIUM RESEARCH...

"After graduating in 1951 with an M.S. in metallurgical engineering, I joined the Metals Research Laboratories of Electro Metallurgical Company. Some of my research in corrosion behavior and notch sensitivity resulted in a patent for a stainless steel. In 1954 I was promoted to Section Leader, supervising research projects in titanium and other reactive metals."

IN ATOMIC ENERGY...

"I graduated in '51 with a B.S. in physics and mathematics. Because of my interest in atomic energy I joined Union Carbide Nuclear Company at Oak Ridge in April, 1954. By November of that year I was classified as a Junior Physicist. I now supervise the operation of mass spectrometers used to analyze radioisotopes produced in atomic reactors here at Oak Ridge."



IN QUALITY CONTROL...

"I'm an electrical engineer, Class of '51. I started in Works Engineering at a National Carbon Company plant. A year later I transferred to a location where Works Engineering covered three plants, and soon became Engineer on important development projects. I was recently promoted to Assistant Head of the Product and Process Control Laboratory at one of the plants."

IN METALLURGICAL CONTROL...

"I'm a metallurgical engineer, Class of '49. I started at Haynes Stellite Company as a Development Engineer in high-temperature alloys, and in 1953 became Shift Foreman in the Metallurgical Control Department. Recently I was promoted to General Foreman, responsible for the Chemical, Spectographic, Material Release, and X-Ray Departments and the Test Laboratory."

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Industrial Relations Department, Room 406
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ALUMNI ENGINEERS

Bernace B. Weber, CE '04, was recently honored by a front page article in the Oil City Derrick marking his fiftieth anniversary with the city engineering department of Oil City, Pa. Previously, in recognition of his long and faithful service to Oil City, he was presented with the "Veterans' Award," a bronze medal and engraved certificate, by the American Public works Association at a banquet in the Hotel William Penn in Pittsburgh. Weber began, January 10, 1906, as assistant to the city engineer and became city engineer in 1913. Since 1906, Weber survived changes of political administration and has been directly involved with local works problems created by the depression, during which time he doubled, supervising construction, and handling employee employer relations. A member of the American Public Works Association and the National Society of Professional Engineers, he lives in Oil City at 109 Cowell Avenue.

Eric A. Andrews, CE '27 is commissioner of public works for the city of White Plains, New York where he lives at 85 Rockledge Avenue. He is the newly elected president of the New York State Association of Municipal Engineers.

Sidney Oldberg, ME '29, has been named director of automotive research, with headquarters in Detroit, Michigan, of Eaton Manufacturing Company, Cleveland, Ohio. Since joining Eaton in 1945, Oldberg has been in charge of research and development engineering at the Detroit laboratory. He and Mrs. Oldberg have three children and reside at 762 Puritan Avenue, Birmingham, Michigan.

William R. Heath, ME '22, 119 Wingate Avenue, Buffalo 16, New York, is executive vice-president of Buffalo Forge Co. A member of the company since 1922, Heath has been a director since 1951 and vice-president, manufacturing, since 1953.

Thomas O. Nobis, BCE '43, is a contractor with Central Engineering Co., Davenport, Iowa, where he lives at 2612 Wood Lane.

Jesse M. Van Law, ME '27 of 3 Glenn Road, Larchmont, New York, is a certified life underwriter in the life insurance and pension planning business. He is president of the Larchmont Community Chest and chairman of the activities committee of the Cornell Club of New York City.

Kenneth A. Kesselring, BEE '41, 1916 Bentley Road, Schenectady 9, New York, is manager of reactor engineering at the Knolls Atomic Power Laboratory. He is married and has three children, Pamela, Deborah, and K. Robert.

Rollin H. McCarthy, ME '21, has been promoted by the Western Electric Company, manufacturing and supply unit of the Bell Telephone System, to the post of assistant engineer of manufacture, with offices in New York City.

Mr. McCarthy, who in his new position will supervise the company's building construction program, received the degrees of ME and MME from Cornell's College of Engineering in 1922 and 1925 respectively. After a period on the instructional staffs of Cornell and the University of Nevada, he entered Western Electric's Hawthorne Works in Chicago, Ill., 27 years ago, where he was engaged in manufacturing development. Since 1937 he has been with the company's Kearny Works in New Jersey, and for the past three years he has had charge of engineering and manufacture of submarine amplifiers, which are being made at the Hillside, N. J., Shop for the new transatlantic telephone cable.

Mr. McCarthy is the author of a number of papers on engineering which have appeared in technical publications and has been active in the American Society of Mechanical Engineers as chairman of the wood industries division and the production engineering division. During World War I he was a second lieutenant in the U. S. Signal Corps.

Mr. & Mrs. **Thomas Clark, C.E. '94** are featured in the January issue of The Scroll of Phi Delta Theta, national fraternity magazine. The Clarks are regular panelists on the CBS television show, "Life Begins at 80."

Samuel A. Bingham, ME '05 is retired and living in Tryon, N.C. He reports that there are two Classmates also living in Tryon, **Ted Blair** and **George Chapman**.

Charles T. Morrow, ME '23, 12 Brandywine Boulevard, Wilmington 3, Del., became a grandfather for the first time last July when a son, Peter Morrow Robinson, was born to Morrow's daughter, Mrs. Paul R. Robinson (Sally Morrow) '51.

M. Robert Seldon, BEE '43 married Storma Lane of Dallas,. Tex. last October and is now living in Dallas at 2311 Garapan Drive. He works at Chance Vought Aircraft as supervisor of the Reliability Design Group.

Jacques L. Zakin, Chem.E. '49, senior research technologist with Socony Mobil Oil Company, has been named the winner of Socony Mobil's 1956 Incentive Fellowship Award. Mr. Zakin resides with his wife and son in Flushing, N.Y.

Joseph S. Gowdy, C.E., has been appointed a sales representative in Texas and Oklahoma for Heppenstall Company, Pittsburgh steel forgings manufacturer. He served with the Civil Engineering Corps of the Naval Reserve.

Harold B. Maynard, M.E. '23, received an honorary degree of Doctor of Laws from the University of Miami, Coral Gables, February 6, where he addressed the midterm graduating class. The citation termed Mr. Maynard "a distinguished international authority in management who has applied with ingenuity and understanding the process of management science to a broad range of human affairs." Mr. Maynard is founder and president of Methods Engineering Council, a Pittsburgh firm of management consultants, and has made many original contributions in the field of scientific management.

LOOKING BACKWARD . . . 10 YEARS FROM NOW

What will you have to show for yourself?

How much will you have contributed in answer to the pressing demands of an unbelievably exciting period in engineering achievement? How satisfying your progress and your rewards?

The coming decade is, for you, a time of transition. In whatever field you choose to pursue a career, your record of advancement from neophyte to veteran will not depend on ability alone. For . . . without ample opportunities to demonstrate your talents, you cannot prove your potential value in any industry.

Today, at Sikorsky Aircraft, the challenge is a mighty one. Solutions to the intricate problems of advanced rotary wing aircraft will have great bearing on military and commercial progress in the years just ahead. To help provide the right answers, more engineers with foresight and vision are needed.

Challenging projects, excellent facilities, creative freedom, recognition of proficiency, merited promotions and rewards, liberal company policies inclined toward family well-being . . . *ALL* contribute importantly to a young engineer's success. Your career at Sikorsky Aircraft, reviewed ten years hence, would doubtless reveal a most satisfactory record, both personally and professionally.

write today . . .
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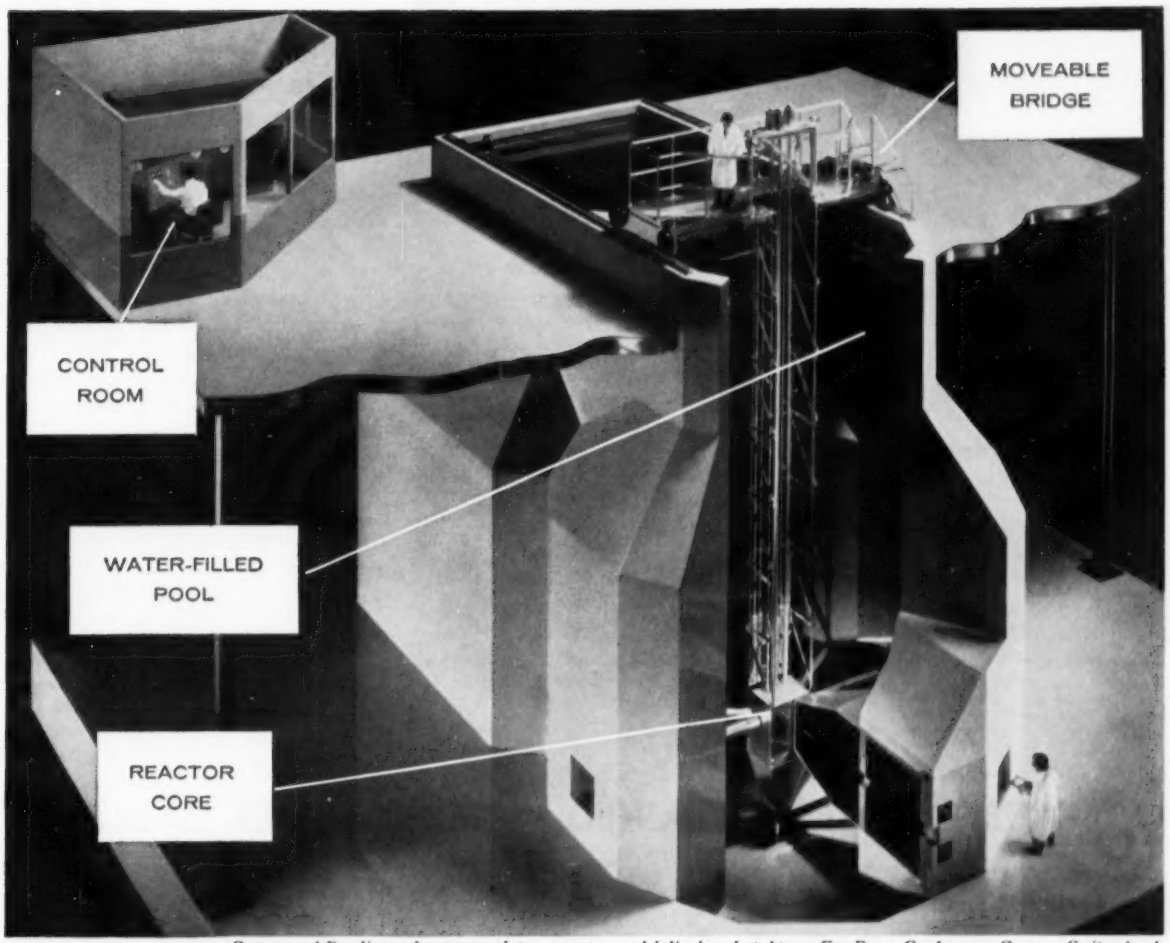

Cutaway of Bendix nuclear research type reactor model displayed at Atoms For Peace Conference, Geneva, Switzerland.

One of Today's Great Engineering Firms Builds for Tomorrow!

The atom has been split and the bomb has been built, but where we go from here depends largely on the strange structure in the photo and others like it. It is a nuclear *research type* reactor. Right now scientists have literally thousands of ideas for putting the atom to work in medicine, biology, chemistry, metallurgy. But they need this reactor to hatch the eggs—are handcuffed without it.

If this nation is to keep pace with the progress of other countries throughout the world, reactors must be built in ever-increasing numbers by those companies whose achievements qualify them for this vital work.

Bendix experience on nuclear projects qualifies it as a top source for research reactors. For eight years our Kansas City Division has been operated exclusively for the Atomic Energy Commission; for five years our Research Laboratories Division in Detroit has worked on design of research reactors, reactor power plants, control components, reactor simulation equipment and nuclear power plants.

For this work Bendix needs men, lots of them . . . talented young engineers with ambition and curiosity. These are the kind of men who, for so many years, have kept Bendix in the forefront as a supplier of a thousand different products to almost every type of industry in existence. For Bendix is in many businesses besides nucleonics. Whatever your field, whatever your geographic preference, it's likely that Bendix has the job you're seeking in one of its twenty-six divisions from coast to coast. See your placement director or send for the brochure "Bendix and Your Future" for a detailed look at Bendix activities.

Bendix
AVIATION CORPORATION
FISHER BLDG., DETROIT 2, MICHIGAN

(Continued from page 18)
all the uses to which this direct conversion of nuclear energy might be put, the prospect of an entirely different power source is a particularly exciting one for the electronics industry . . . Progress in increasing the efficiency of the RCA Atomic Battery has been rapid during the past few months and is expected to continue. Results to date indicate the possibilities of producing thimble-sized atomic batteries . . . [that] can supply power . . . without replenishment or attention for at least twenty years".

Such is the outlook for the atomic battery. For a device that many said "couldn't be made" it certainly holds great promise for the future.

Are these the only sources of electric power the future will have? Not necessarily. There are forces as old as the earth which are yet to be harnessed. The winds are one of these. For centuries there have been windmills to grind grain for the daily bread. Windmills have pumped water, both to drain land and to irrigate it. Wind was used to power sailing vessels before the steam engine was invented. Many men have attempted to make wind machines, and failed. Some succeeded.

In 1939, Palmer Cosslet Putnam, a Boston engineer, decided a hilltop would be an excellent location for a wind generator, since there is often a steady breeze on top of a ridge of hills. A wind generator could be designed much more efficiently, too, now that aviation experts had gained considerable knowledge of how air flowed around an airplane wing. A wind turbine was built and erected on a mountain called Grandpa's Knob, near Rutland, Vermont. The tower for the turbine was one hundred twenty-five feet tall — just tall enough to carry the two bladed impeller which had a diameter of one hundred seventy-five feet. This impeller was mounted in such a way that it turned into the wind automatically. The apparatus was put into operation in October, 1941, and ran almost without serious interruption until March, 1945 when one of the blades was torn loose. Because of the war, the materials necessary for repairs could not be obtained, and the structure was abandoned. However, its operation furnished engineers with information about the design of large wind-power units and proved that such devices were feasible.

Another source of electric power that is yet to be tapped is volcanic heat and the internal heat of the earth. The people of Larderello, Italy, have tamed a volcano so that their power plants supply the electric current for all of the surrounding areas. Adaptations of their equipment would enable us to utilize the tremendous heat of the earth's interior.

Men have many more ideas about developing new sources for electric power. Some are practical, some are in the experiment stage, and some are still dreams. But almost all of them could be used if the necessity arose. We need not dread the day that coal and oil are used up, for by then at least one other source of energy will have been developed to replace it.

CRESCENT INTERLOCKED ARMOR POWER CABLE

For more than 70 years CRESCENT INSULATED WIRE AND CABLE has met the highest standards of safety and economy in electrical wires and cables for homes, factories, farms and public buildings. This company through its program of research and development has made major contributions to the science of wire and cable production.

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C. Edward Murray, Jr. '14

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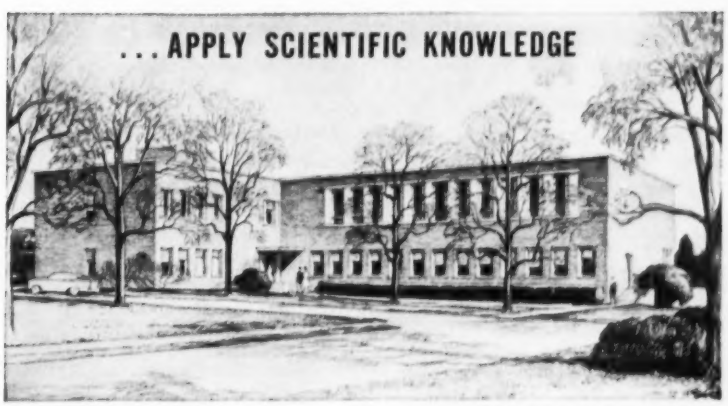
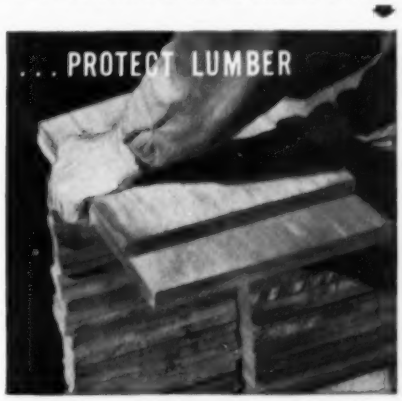
IN HEAVY TRAFFIC AREAS like this, floor tiles must be built to take a beating. Whether the tiles are of the rigid, mastic type or flexible flooring based on rubber or vinyl, Hercules Neolyn®, Mastolyn® or Staybelite® resin can contribute to lower processing costs and better wearing qualities. The wide variety of properties offered by these resins assures that there is one best suited for every floor tile formulation.



MORE THAN 17,000 VOLUMES of scientific literature and tens of thousands of company research reports will be housed in this new $1,000,000 Technical Information Center at the Hercules Experiment Station near Wilmington. In addition, the structure will provide quarters for the many technical specialists who serve the scientific information needs of the Hercules research staff—making the Center one of the nation's most complete information services to an industrial research organization.

WHICH HAD THE TREATMENT? The clean, unsplintered piece has been treated with Hercules Paracol® wax emulsion, making it possible to use every inch of lumber that has been pre-cut at the mill. The untreated piece (top) is badly "checked" and a portion of the end must be discarded before it will be suitable for use.



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G55-13

HERCULES

CHEMICAL MATERIALS FOR INDUSTRY

College News

The recent display in the first floor showcases in Thurston Hall was presented by the Lukens Steel Company, manufacturers of specialized steel products. The company is well known for its armor plating and large rolling mills from which the plates for the hull of the U.S.S. Nautilus, the world's first atomic submarine, were made.

Included in the exhibit was a panel, given to Cornell for permanent display, describing clad sheets. Clad sheets are plates consisting of thin layers of high alloy material on their surfaces which are bonded to low grade steel called backing. Sheets are bonded two at a time in large rolling mills under heat and pressure which insures a tight bond between the two alloys. The advantage of the clad sheets is that only 10 to 20 per cent high alloy, corrosion resisting metal is used instead of 100 per cent. Accompanying this display are small specimens of clad sheets showing the deformation produced after they had been subjected to shear, compression and tension tests. The tension and compression tests are illustrated with a metal strip bent into the shape of a flat "s", the metal on the outside curve being in tension and that on the inside portion being in compression. The samples show that the clad layer does not separate from the steel backing under the above conditions. Also in the display are specimens of welded clad sheets which indicate the different types of welds used for varying thicknesses.

Other parts of the exhibit illustrated the unusual processes and machines employed by the steel industry in meeting requests for unorthodox products. Pictorial views of a flame cutting technique, which allows cutting of 20 inch metal thickness, were shown as well as a huge 206 inch wide rolling machine which will make the hull plates for the Navy's newest supercarrier, the U.S.S. Saratoga. In addition there was a picture of the world's largest spinning machine, capable of spinning metal twenty-three feet in diameter. To demonstrate the exactness of such large operations, a cut-away model of a compressor housing after it has been fitted together was displayed. Samples were also displayed of a pressed and punched table base and gear which eliminate a previous loss of 5 per cent due to faulty castings.

Display recently shown in Thurston Hall, presented to Cornell University by the Lukens Steel Company.

The Thurston exhibits are designed to stimulate interest in engineering and to show practical applications of the theory which students must learn. The displays demonstrate extensively many of the industrial applications of theory to practice, and consequently enable students to have a broader background of the practical side of engineering than the university is capable of presenting otherwise. In addition the displays feature the latest developments in engineering and science.

Construction Problem Solved By Cornell Professor

The solution of a construction snag on a new dam on the Missouri River is credited to Prof. P. P. Bijlaard, structural engineer at Cornell University.

From his Ithaca office last summer, Professor Bijlaard determined the stresses that were cracking huge Y-shaped pipes at the Garrison Dam in North Dakota, and suggested a solution which enabled the dam to start operation on January 20.

The completed dam will have five 24-foot diameter tubes called "penstocks," each connected by 16-foot Y-shaped "risers" to two surge tanks. Three of these units were already under construction when the cracking occurred during welding.

Continued on page 46)

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- Microwave Ferrite Devices
- Antennas and Radomes
- Indicator and Microwave Tubes
- Semiconductor Devices

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LAVA CRUCIBLE-REFRACTORIES CO.
PITTSBURGH, PA.

WHAT'S THE TREND IN PRODUCT DESIGN?

It affects your future as a development engineer

INDUSTRY'S forecasts predict constantly growing competition for customers. As a result, tomorrow's designs will be based on two major premises: dependability and cost.

With rising costs of materials and labor, industry is searching for ingenious engineers to show them how to develop and manufacture their products at a profit . . . and still keep selling prices down.

The engineer who knows how to use materials like welded steel to eliminate unnecessary cost will command key positions in industry. Welding holds the answer to many design dilemmas where costs must be cut and products made stronger, more rugged.

The example shows how one machine component has been made more durable... yet the cost was cut from 85¢ to 65¢ a piece. Because of steel's higher strength, greater rigidity and lower costs, similar reductions in cost are possible in virtually all products now made from gray iron.

Latest design ideas in changing over parts from gray iron to steel are available to engineering students by writing

THE LINCOLN ELECTRIC COMPANY
Cleveland 17, Ohio
The World's Largest Manufacturer of Arc Welding Equipment

Prof. P. P. Bijlaard

College News

(Continued from page 44)

After trying one unsuccessful remedy, the engineers called on Professor Bijlaard. He suggested reinforced concrete around the whole unit, an operation amounting to 7,000 cubic yards of concrete and $1,500,000 for the three units that had been started.

The September Bulletin of the Geological Society of America cites another phase of Professor Bijlaard's work in an article about the recent discovery of four mountain ranges under the Pacific Ocean. Their position substantiates his theories of 20 years ago about the stresses that determine the angles of mountain ranges and other earth fractures.

Professor Bijlaard is also the author of an article in the December issue of the Welding Journal. It is entitled "Stresses from Radial Loads and External Moments in Cylindrical Pressure Vessels."

Professional Degrees

Seven professional master's degrees in engineering have been authorized by the Cornell Trustees and will be offered by the Cornell Graduate School in a program beginning next fall. Cornell will grant master's degrees in chemical, civil, electrical, industrial, mechanical and metallurgical engineering and in engineering physics. Specialization within these divisions will include the fields of electronics, thermal engineering, administration, plastics, nuclear engineering, transportation engineering and biochemical engineering.

Cornell will continue to grant M.S. and Ph. D. degrees in engineering, but these degrees will still require a thesis, whereas the new professional master's degree will not.

A minimum of 45 credit hours will be required for the new degree, at least 15 of them on the Cornell campus. As much as 15 hours' credit can be given for previous advanced work not normally included in a four-year engineering curriculum. Exceptional persons may get credit for industrial experience in the field covered by a particular course.

For admission a student must hold a bachelor's degree from a recognized school of engineering or science, or have completed four years in Cornell's College of Engineering. Cornell engineering students may complete the master's degree in a minimum of one term beyond the fifth year of engineering study.

A newly created Engineering Division of the Graduate School, consisting of the graduate faculty in engineering, will have general con-

(Continued on page 48)

Allied Chemical

IS A COMBINATION OF SEVEN GREAT OPERATING DIVISIONS.

Each stands out in its own field of chemical manufacturing. Taken all together they give Allied an exceptional diversification of more than 3000 products—ranging from basics and intermediates to chemical products serving just about every industry.

Allied's diversity of operations is made possible by a broad and comprehensive research program. The Central Research Laboratory works closely with 11 divisional research laboratories to develop new and better products and to improve processes. Because Allied starts with basic chemicals, the avenues of research open in every direction. This means better opportunities for a wide range of talents in the most promising fields of chemistry.

Barrett

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Coal-Tar Chemicals, Resins, Plastics and Plasticizers, Roofing, Insulating Board and other Building Products, Bituminous Road Materials, Pipeline Enamels, Wood Preservatives, Industrial Pitches.

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MUTUAL CHEMICAL DIVISION
Sodium Bichromate, Sodium Chromate, Potassium Bichromate, Chromic Acid, "Kareon," and other chromium chemicals.

NATIONAL ANILINE DIVISION
Dyestuffs and Certified Food Colors, Industrial Intermediates, Synthetic Detergents, Pharmaceuticals, *caprolan* Nylon Fiber.

NITROGEN DIVISION
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SEMET-SOLVAY DIVISION
Coke and By-Products, Coal, Gas Producing Apparatus, Wilputte Coke Ovens, A-C Polyethylenes.

SOLVAY PROCESS DIVISION
Alkalis, Chlorine, Calcium Chloride, Ammonium and Potassium Compounds, Alkali Cleansers, Chlorinated Hydrocarbons.

A Tower of Opportunity

for America's young engineers with capacity for continuing achievements in radio and electronics

Today, engineers and physicists are looking at tomorrow from the top of this tower . . . the famed Microwave Tower of Federal Telecommunication Laboratories . . . a great development unit of the world-wide, American-owned International Telephone and Telegraph Corporation.

Here, too, is opportunity for the young graduate engineers of America . . . opportunity to be associated with leaders in the electronic field . . . to work with the finest facilities . . . to win recognition . . . to achieve advancement commensurate with capacity.

Learn more about this noted Tower of Opportunity . . . its long-range program and generous employee benefits. See your Placement Officer today for further information about FTL.

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A Division of International Telephone and Telegraph Corporation
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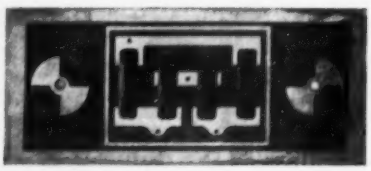
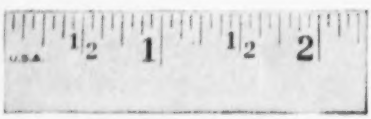
An idea with great promise

How electronic parts are now printed



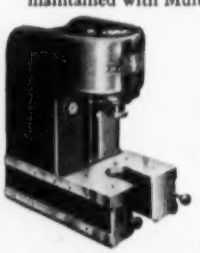


with DENISON hydraulic equipment

Resistors and other precision electronic parts are being produced now by a printing process to save materials and lower costs.

Here, for example, is an electronic resistor made 3 times faster than before. It is printed on a Denison hydraulic Multipress® to hold close tolerances.

The uniformity of carbon ink deposits maintained with Multipress holds tolerances within 6% on resistors ranging from 100 ohms to 2 megohms. The critical timing and pressure required for such accurate duplication of carbon ink are controlled by split-second, time-hold delay and precision ram pressure possible on the Denison hydraulic Multipress.



Hydraulic specialists from Denison are helping industry solve endless design and production problems today. The need for such hydraulic skill is growing fast day by day.

Find out more about Denison and your future in hydraulics. Write to

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A Subsidiary of American Brake Shoe Co.

DENISON HydrOILics

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College News

(Continued from page 46)

trol over the advanced professional degree work, the administration of which will be in the hands of a Graduate Committee on Engineering, composed of representatives elected to two-year terms by the faculties of their engineering school or department.

Additional information on the program may be obtained from the Graduate School, Day Hall.

Smith Appointed to Committee

Prof. G. V. Smith of Cornell has been appointed to the Sub-committee on Aircraft Structural Materials of the National Advisory Committee for Aeronautics.

He is a professor of metallurgical engineering in Cornell's School of Chemical and Metallurgical Engineering.

High-Speed Photography

Jay W. Baxtresser, Chief Photograher of Cornell Aeronautical Laboratory, Inc., addressed the Technical Section of the Photographic Society of America February 16 on the campus of Cornell University. He discussed "The History and application of High Speed Photography" and showed films of high speed techniques.

High speed photography can be traced back to 1872, Mr. Baxtresser told the groups, and the constant development in the past few decades of new instruments to study events occuring in very brief time intervals were discussed. Mr. Baxtresser also gave examples of equipment used at the Laboratory and described major types of high speed motion picture cameras.

Schlieren techniques, which make density variations strikingly obvious and permit the study of many types of waves were explained in the talk.

Among Laboratory studies using high-speed camera techniques have been flame studies, jet vanes, rain erosion, auto crash and projects carried out in the hypersonic shock tunnel.

Mr. Baxtresser has been with Cornell Laboratory for five years. He was formerly director of photogaphy at Bell Aircraft Corp. in Buffalo. He has produced institutional, technical, and TV films.

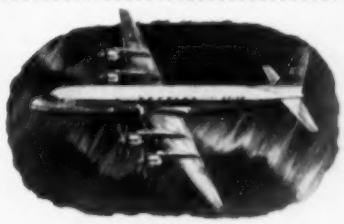
F4D, "SKYRAY"— only carrier plane to hold official world's speed record

A4D, "SKYHAWK"— smallest, lightest atom-bomb carrier

RB-66 — speedy, versatile jet bomber

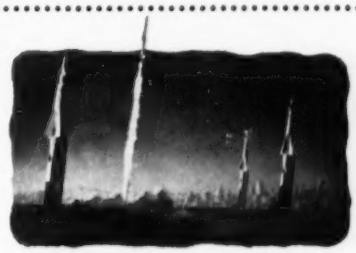
A3D, "SKYWARRIOR"— largest carrier-based bomber

C-124, "GLOBEMASTER"— world's largest production transport

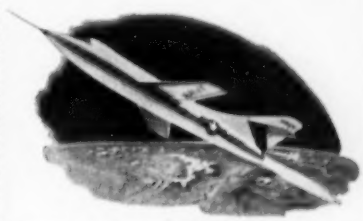


DC-7 "SEVEN SEAS"— America's finest, fastest airliner

Engineers: join this winning team!



"NIKE"— supersonic missile selected to protect our cities



D558-2, "SKYROCKET"— first airplane to fly twice the speed of sound

At DOUGLAS you'll be joining a company in which the three top executive officers are engineers...you'll be associated with men who have designed the key airplanes and missiles on the American scene today! Nothing increases an engineer's ability faster than working with other engineers of top calibre.

Not only is Douglas the largest manufacturer of commercial aircraft in the world, but it also produces outstanding aircraft and missiles for *every* branch of the armed services! This diversity, besides giving you job security, provides unequalled opportunity for the engineer with an eye to the future.

Challenging opportunities now exist in the following fields:

Mechanical design
Structural design
Power plant installation design
Weapons delivery
Aerodynamics
Thermodynamics
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Aircraft air conditioning
Hydraulics
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Servo mechanisms
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Electronics
Mechanical test
Structural test
Flight test
Process engineering
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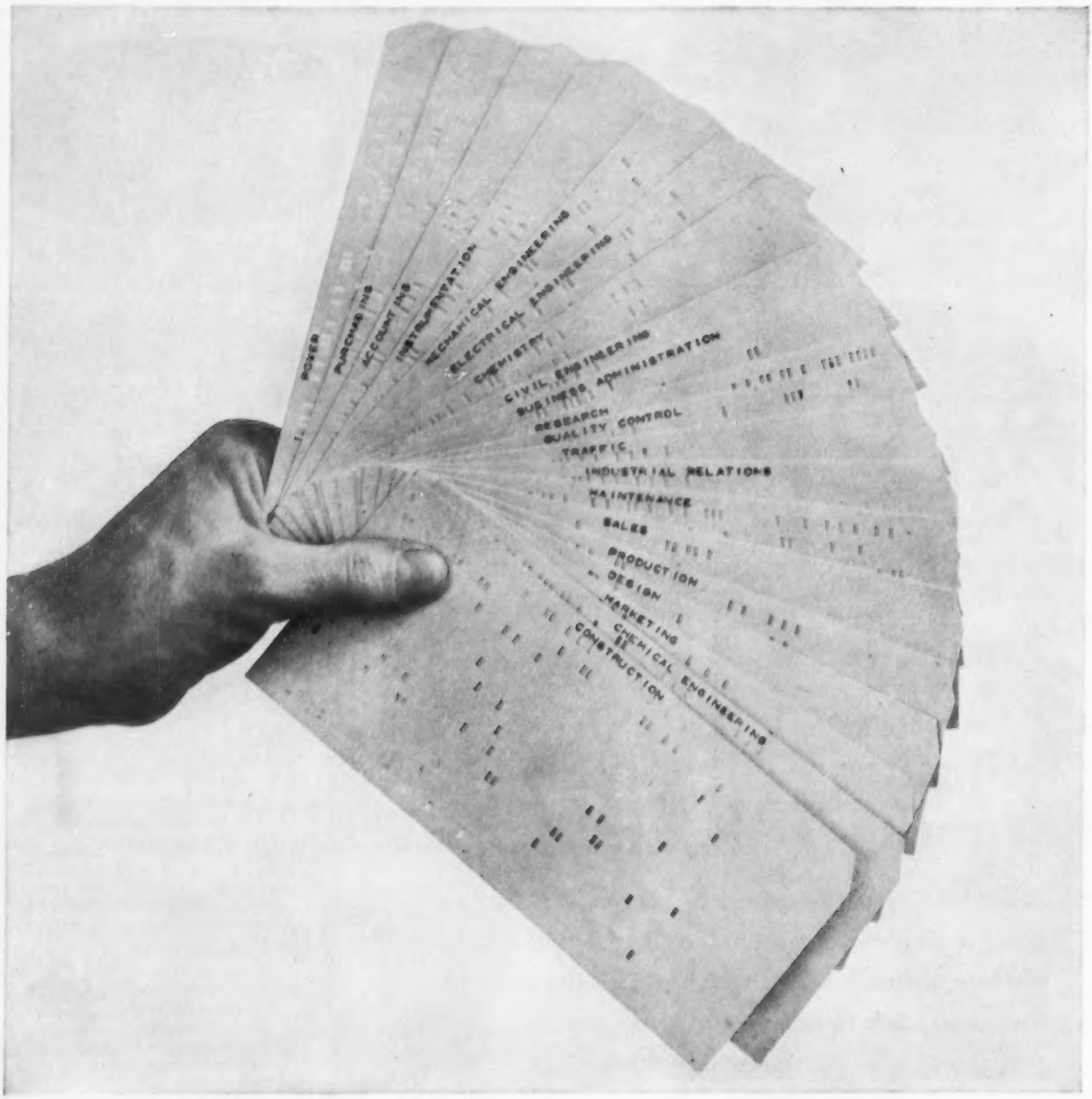
Brochures and employment applications are available at your college placement office.

For further information relative to employment opportunities at the Santa Monica, El Segundo and Long Beach, California divisions and the Tulsa, Oklahoma division, write today to:

DOUGLAS AIRCRAFT COMPANY, INC.

C. C. LaVene, Employment Manager... Engineering General Office
3000 Ocean Park Blvd.... Santa Monica, California



Which of these careers would you pick at Columbia-Southern?

If any of the fields above represent the one in which you want to make your career, then you should look into Columbia-Southern right away.

Columbia-Southern is one of the fastest-growing companies in the rapidly expanding chemical manufacturing industry. There are always excellent opportunities for capable young college graduates to become a vital part in the company's steady growth and expansion.

The principal activity of Columbia-Southern is chemical production—but the company also designs, builds and maintains its own plants and the equipment in them; owns and operates coal and limestone mines, brine wells, and a fleet of tank cars and barges; sells its products to every segment of industry in the United States and in other countries; and helps its customers put Columbia-Southern chemicals to work in producing many of the things essential to an ever-improving standard of living.

These varied activities require a corresponding variety of special skills. The opportunities are many. Columbia-Southern offers qualified graduates a liberal starting salary. A thorough "on-the-job" training program aids the new employee in learning more about his job and the company. Each employee's progress is reviewed periodically to insure that salary level keeps pace with demonstrated professional growth and increased responsibilities.

For further information on your opportunities at Columbia-Southern, write now to Dept. P at our Pittsburgh address or any of the plants.

COLUMBIA-SOUTHERN CHEMICAL CORPORATION

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Technibriefs

High-Speed Camera

High-speed cameras that record as high as 15 million picture frames a second were described recently by George T. Eaton of Kodak Research Laboratories in a talk, "Photography in Science and Engineering."

Eaton said that camera units having film wrapped on a revolving drum, or based on a rotating mirror principle, utilize high-intensity, short-duration exposure to reach "almost fantastic recording speeds." Other cameras, with conventional film sprocket drive, are capable of speeds up to about 10,000 frames per second.

High-speed movies are finding increasing applications in science and industry. Some of these uses are measurement of mechanical and electrical effects, determination of velocities, study of welding arcs, and analysis of fundamental chemical processes. They are also proving useful in study of combustion processes and explosive reactions, including guided missile, rocket, and atomic bomb research.

One superfast camera, the Hycon Submicrosecond, has an exposure time of one ten-millionth of one second. It is used to study practice motion in blast furnaces and jet engine combustion.

Eaton pointed out that some analytical problems cannot be solved without photography because the photographic emulsion is the only medium capable of recording invisible radiations. An outstanding example, he said, is the recording of the tracks or paths of some types of nuclear particles resulting from the bombardment of atoms of cyclotrons or similar equipment.

The speed of these particles in air is reduced by the stopping power of the gelatin emulsion to a point where their path of progress is revealed by a developed silver image. Microscopic examination then provides such data as the angle of penetration and the length of the path, from which the energy of the particle, then the identification of the particle itself, can be determined.

Uranium Dectector

Uranium Detector

For the weekend uranium prospector with a pinched pocketbook, a new low-cost ($8.49) detector is being offered by CMG Industries, Laramie, Wyoming. The detector is a pocket sized daytime black light device using ultra-violet light from the sun. A sample is held inside the detector, and making use of the fluorescent property of uranium compounds, an approximate assay can be obtained. The device was designed by two University of Wyoming scientists and it is claimed that the kit has actually detected commercial uranium passed up by expensive counters.

Solar Powered Radio

A pocket-size solar-powered radio receiver, weighing only 10 ounces and capable of working more than eight months in total darkness without recharging, has been developed by General Electric Company.

Major advantages over solar-powered receivers previously announced are size and length of operation in absence of light.

Pointing out that highly efficient solar batteries such as those used in the receiver are still too expensive to justify manufacture of devices in which they play an important part, the company disclosed that it has no immediate plans for production.

The solar receiver will operate continuously in daylight and will run 500 hours in darkness without recharging. If used at the rate of two hours a day, which is considered normal usage for a portable radio, it would work for a minimum of 250 days in absolute blackout.

Long operation in total darkness is made possible by the use of a minature storage battery which is contained in a transparent plastic case along with four transistors, seven solar cells and other components. The case is 5½ inches wide, 1¼ inches thick and 3 inches high.

The present size makes it convenient for the user to place the receiver in a suit pocket and to hear programs with a minature ear-plug. The size could be cut in half, by substituting sub-miniature components now in existence which were unavaliable when developmental work was being conducted. Only two manual controls are needed—a turn-on knob which also adjusts volume and a knob for station selection.

The company said the primary benefit of solar power over other power sources, as demonstrated in the new equipment, is that there is no necessity for battery replacement. Transparency of the case permits battery - charging by simple exposure of the unit to the sun's rays.

Under normal daylight conditions, light rays strike the selenium cells which convert solar energy to electrical current. The electrical energy travels directly to transistors in the daytime, powering the receiver. Simultaneously, the miniature storage battery builds up a supply of energy to be employed when sun-power is lacking.

Artificial light such as a lamp containing a 100-watt bulb, may be used instead of sunlight. Smaller artificial sources, such as matchlight or candlelight, do not provide the necessary light power.

(Continued on page 52)

TECHNIBRIEF'S

(Continued from page 51)

Metallurgical Developments

A new device, utilizing the elementary chemical fact that carbon and oxygen have a strong natural affinity for each other, is now being used at U. S. Steel's Research Center in Monroeville, Pennsylvania, to measure within 5/10,000 of a percent the carbon content of low-carbon steels.

The apparatus was designed and developed in answer to the growing need for closer control of carbon in steels where this element is a decisive factor in quality and performance. For example, in high silicon steels for transformers or dynamos, carbon must be kept to a minimum. In enameling steels, certain quantities of carbon are necessary but must be controlled to very close specifications for best results. The new equipment is used only in the analysis of steels where accuracy greater than that provided by standard equipment is required, usually in the range below .03 per cent carbon.

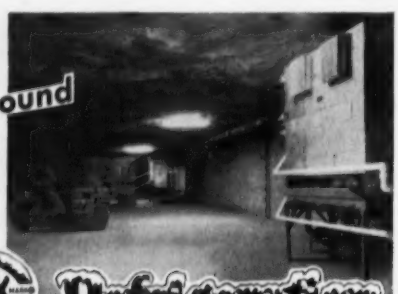
Vacuum analyzer for determining carbon content of steels.

The steel samples to be analyzed consist of small chips and shavings. These are carefully weighed and then placed in a glass rack containing a number of pockets to hold several different types of samples. The rack is sealed into a vacuum system and mounted directly over a combustion chamber. Samples are drawn into the combustion chamber by a magnet applied by the operator to the outside of the glass.

The combuistion chamber is a platinum crucible lined with aluminum oxide. It is induction heated to about 1,700 degrees Centigrade. At this temperature the steel sample is burned in the presence of a controlled amount of purified oxygen. The gas CO_2 is generated along with other gases.

These mixed gases then pass through a freeezing trap containing dry ice and acetone to maintain a temperature of -80 degrees Centigrade. At this temperature, the CO_2 passes through as a gas, the interefering gases remain frozen in the trap. The CO_2 is then frozen out in liquid nitrogen and released into a pressure gage. Since the carbon dioxide formation depends entirely on the amount of carbon in the steel sample, the gas pressure can then be translated directly into amount of carbon originally contained in the steel being tested.

Another Great Underground Storage Cooled with FRICK Refrigeration

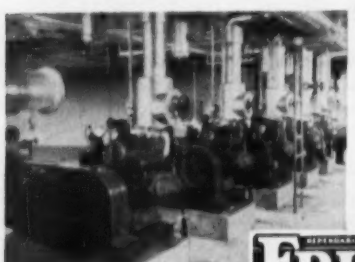


The Inland Cold Storage, Inc., at Kansas City, is remarkable in many ways.

Here over a hundred acres of dry space in a former limestone quarry are available. Three million cubic feet are already refrigerated. Quick-freezing capacity is 60,000 lb. per day; freezer storages hold 1200 carloads, and fresh-produce rooms another 300 carloads.

Five Frick "ECLIPSE" ammonia compressors and 40 Frick air cooling units, among other equipment, supply refrigeration to the huge rooms through the medium of cold brine.

Get data now on the Frick Graduate Training Course in Refrigeration.



Frick "ECLIPSE" compressors

FRICK CO. WAYNESBORO, PENNA. U.S.A.

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Our Athletic and Men's Wear Department is geared for Spring, with—

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Sport Shirts, including plaids
Belts—Plaids, Madras, Stripes
White Bucks
Caps—Plaids, Stripes

Tennis Rackets
Badminton Sets

Plus our usual line of Cornell Clothing

The Cornell Campus Store

Barnes Hall

GRUMMAN ENGINEERS GO TO SEA

The USS Intrepid turned into the wind and the new Grumman supersonic F11F-1 Tiger was catapulted. Leaving a wake of steam, the catapult shuttle returned to take the second Tiger, waiting to move into launching position. On hand to watch the start of the Tiger's carrier qualification tests were a dozen Grumman engineers. Two days before they had flown to the port of embarkation via Grumman executive airplane. Going to sea is but one of the many interesting possibilities of working at Grumman. To learn about the others, write for your copy of: *Engineering for Production.*

★

Positions available for graduates in aeronautical, mechanical, electrical and civil engineering, mathematics, and engineering physics.

GRUMMAN AIRCRAFT ENGINEERING CORPORATION

BETHPAGE • LONG ISLAND • NEW YORK

Designers and builders of the supersonic Tiger, transonic Cougar, S2F sub-killer, and Albatross SA-16 Rescue Amphibian.

water works even when you're asleep!

This particular need for water isn't acute.

But if . . . as so many students have . . . you elect the challenging field of Sanitary Engineering for your future, you'll come up against many more problems of supplying, distributing, maintaining an adequate supply of water for homes and industries in a thirsty world.

Here, you can count on the help of one valuable ally . . . cast iron pipe. Practically every city in America—large or small—uses it for water and gas mains . . . and over 70 of their public utilities have been served by cast iron pipe for a century or more.

On its record, cast iron pipe is Man's most dependable carrier of water.

CAST IRON PIPE RESEARCH ASSOCIATION

Thos. F. Wolfe, Managing Director, 122 So. Michigan Avenue, Chicago 3, Ill.

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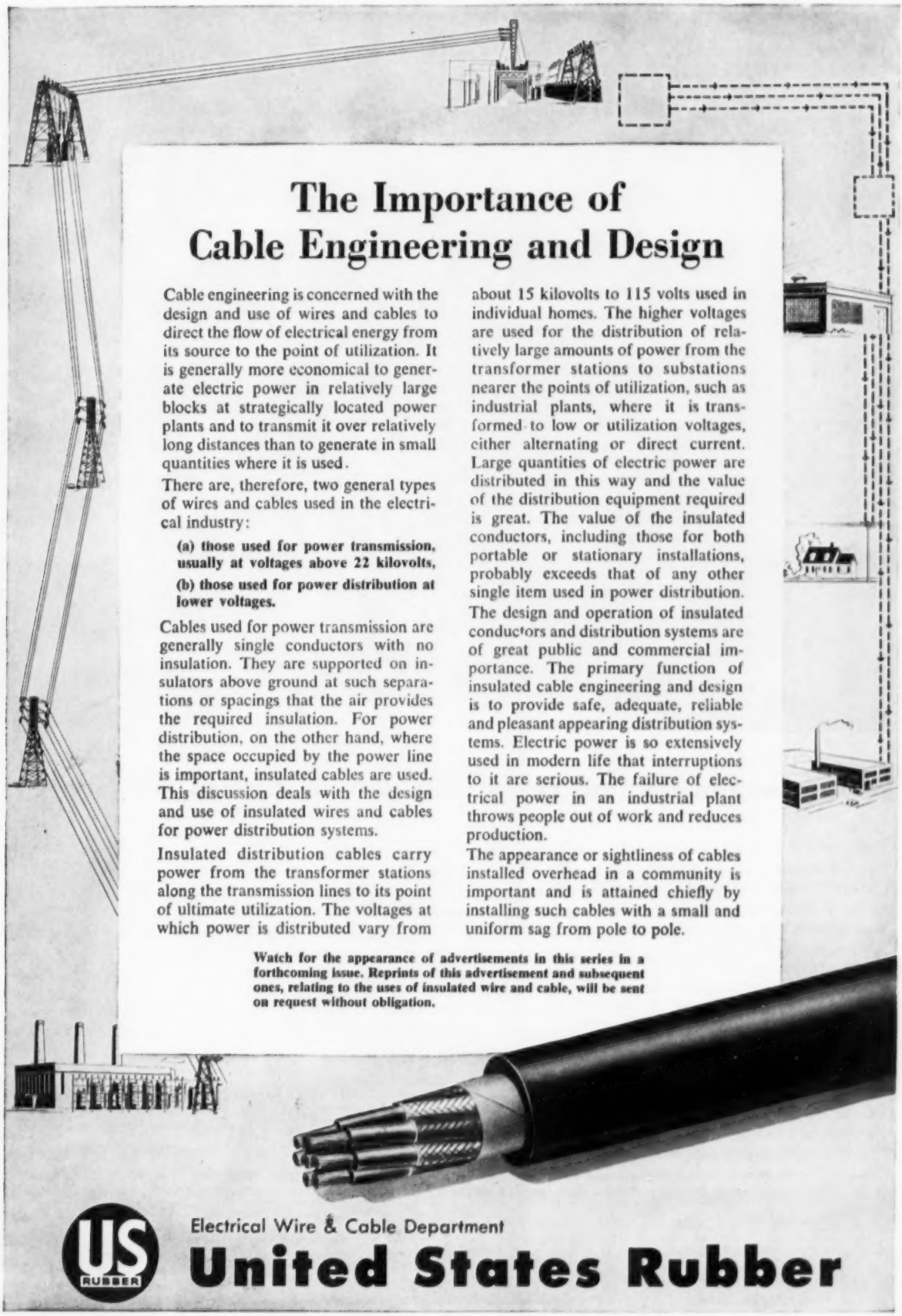
CAST IRON PIPE SERVES FOR CENTURIES



The Importance of Cable Engineering and Design

Cable engineering is concerned with the design and use of wires and cables to direct the flow of electrical energy from its source to the point of utilization. It is generally more economical to generate electric power in relatively large blocks at strategically located power plants and to transmit it over relatively long distances than to generate in small quantities where it is used.

There are, therefore, two general types of wires and cables used in the electrical industry:

(a) those used for power transmission, usually at voltages above 22 kilovolts,

(b) those used for power distribution at lower voltages.

Cables used for power transmission are generally single conductors with no insulation. They are supported on insulators above ground at such separations or spacings that the air provides the required insulation. For power distribution, on the other hand, where the space occupied by the power line is important, insulated cables are used. This discussion deals with the design and use of insulated wires and cables for power distribution systems.

Insulated distribution cables carry power from the transformer stations along the transmission lines to its point of ultimate utilization. The voltages at which power is distributed vary from about 15 kilovolts to 115 volts used in individual homes. The higher voltages are used for the distribution of relatively large amounts of power from the transformer stations to substations nearer the points of utilization, such as industrial plants, where it is transformed to low or utilization voltages, either alternating or direct current. Large quantities of electric power are distributed in this way and the value of the distribution equipment required is great. The value of the insulated conductors, including those for both portable or stationary installations, probably exceeds that of any other single item used in power distribution.

The design and operation of insulated conductors and distribution systems are of great public and commercial importance. The primary function of insulated cable engineering and design is to provide safe, adequate, reliable and pleasant appearing distribution systems. Electric power is so extensively used in modern life that interruptions to it are serious. The failure of electrical power in an industrial plant throws people out of work and reduces production.

The appearance or sightliness of cables installed overhead in a community is important and is attained chiefly by installing such cables with a small and uniform sag from pole to pole.

Watch for the appearance of advertisements in this series in a forthcoming issue. Reprints of this advertisement and subsequent ones, relating to the uses of insulated wire and cable, will be sent on request without obligation.

Electrical Wire & Cable Department

United States Rubber

Boeing engineers find rewarding jobs in Wichita, Seattle

This model of a supersonic airplane design was dropped at extreme altitude from a B-47 Stratojet. Telemetered data revealed the characteristics of its supersonic flight to destruction at the earth's surface. This is just one example of Boeing-Wichita's continuing development of advanced aircraft and associated system components.

At Wichita research and development programs are expanding rapidly. Laboratory space has been quadrupled and many other new engineering facilities have been added to keep pace with increasing emphasis on technical development. At both of the company's plants, Seattle and Wichita, the increased scope and magnitude of this development effort is creating additional and excellent career opportunities for all types of engineers.

This means that if you are an electrical engineer, a mechanical engineer, a civil or an aeronautical engineer or a physicist or mathematician with an advanced degree, there is a real challenge for you in one of Boeing's design research or production engineering programs. You would work in a tight-knit team where there is plenty of room for self-expression and recognition.

Boeing engineers are working now on future airplanes and missiles that will maintain the standard of technical superiority established by the B-47 medium bomber, the B-52 intercontinental bomber, the BOMARC IM-99 pilotless interceptor, the 707 jet transport and the KC-135 jet tanker-transport.

Recognition of professional growth is coupled with career stability at Boeing — twice as many engineers are now employed by the company as at the peak of World War II. They enjoy a most liberal retirement plan. How would *you* like a satisfying, creative job with the pick of the engineering profession? There may be one waiting for you in the progressive communities of Wichita or Seattle.

For further Boeing career information consult your Placement Office or write to either:

JOHN C. SANDERS, Staff Engineer—Personnel
Boeing Airplane Company, Seattle 14, Wash.

RAYMOND J. B. HOFFMAN, Admin. Engineer
Boeing Airplane Company, Wichita, Kansas

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Aviation leadership since 1916
SEATTLE, WASHINGTON WICHITA, KANSAS

ALCOA WANTS YOU

Here's a book that tells about exciting career opportunities in every branch of engineering

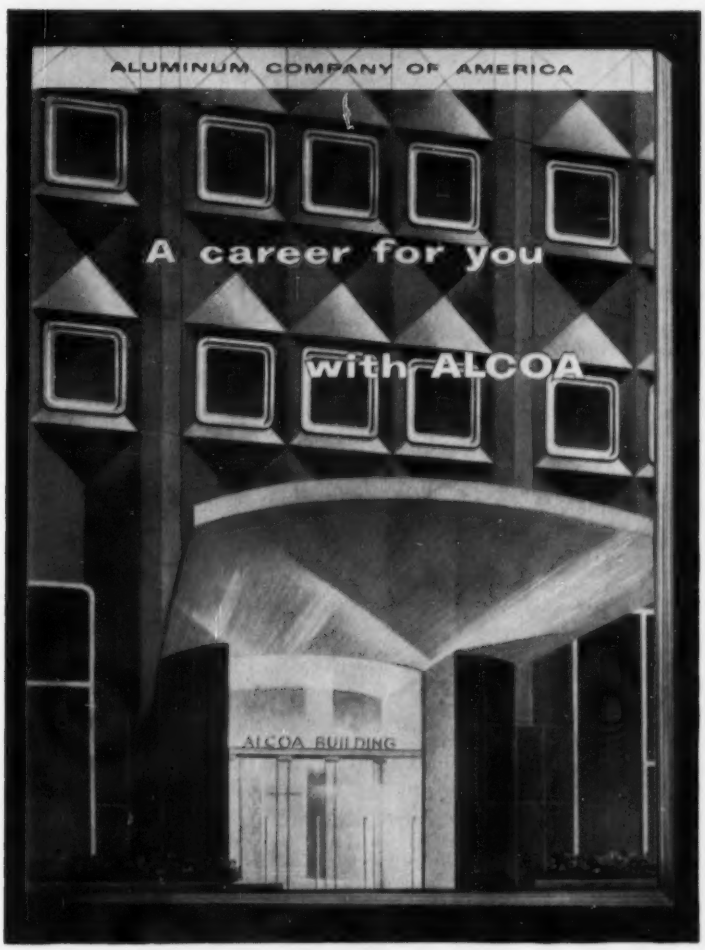
The opportunities at Alcoa are so many, so promising, so rich in recognition it took a book to tell the story. And Alcoa wants *you* to have a copy.

If you choose a career with Alcoa, you'll get intensive training from the men who built the aluminum business. You'll have the opportunity of working in our production plants . . . sales offices . . . research laboratories; and positions are open in almost every section of the country. Your work will be challenging and your associates stimulating.

The whole fascinating story of careers with Alcoa is told in this colorful new book. See your Placement Director or send in the coupon below for *your* copy of *A Career for You With Alcoa.*

Your Guide to the Best in Aluminum Value

ALCOA ALUMINUM



Tune in the ALCOA HOUR, television's finest hour of live drama, alternate Sunday evenings.

Write for your copy today!

ALUMINUM COMPANY OF AMERICA
1825 Alcoa Building
Pittsburgh 19, Pa.

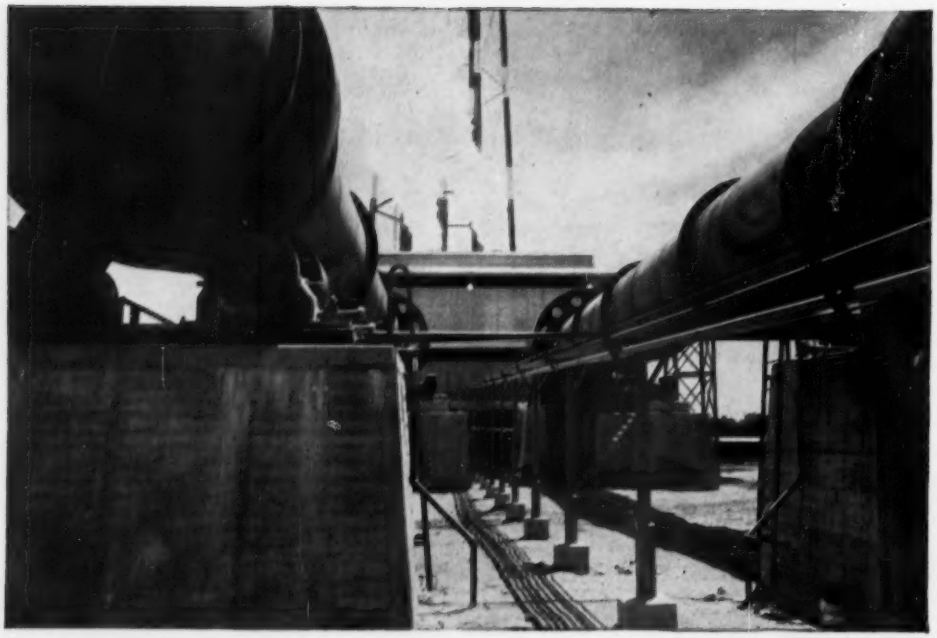
Please send me a copy of *A Career for You With Alcoa.*

Name_____

Address_____

City and State_____

College_____ Degree_____ Date of Graduation_____



CONSTRUCTION— Tremendous rotary kilns, like these, typify Allis-Chalmers role in the cement industry.

Join the company that serves 3 GROWTH INDUSTRIES

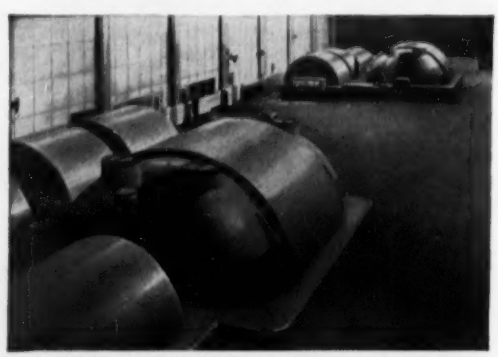
Match your engineering talents to the future needs of the construction, power and manufacturing industries. These are growing needs—for the population is climbing at the amazing rate of 50,000 people every *week!*

Many billions of dollars for highway *construction* alone are called for by the President in the next ten years. Allis-Chalmers builds equipment used in making cement, aggregate and steel as well as earth movers and graders.

Electric *power generation* will double in ten years. A-C builds the machines that make electricity.

Manufacturing output must increase $3.5 billion by this time next year. Allis-Chalmers builds motors, control, drives and many other types of equipment for this industry.

MANUFACTURING—A-C aids high speed production and helps improve quality with dielectric sand core dryers like the one above.



POWER GENERATION—Growing use for power means growing demand for A-C steam turbines, transformers, and other equipment.

Here's what Allis-Chalmers offers to Young Engineers:

A graduate training course that has been a model for industry since 1904. You have access to many fields of engineering: electric power, hydraulics, atomic energy, ore processing.

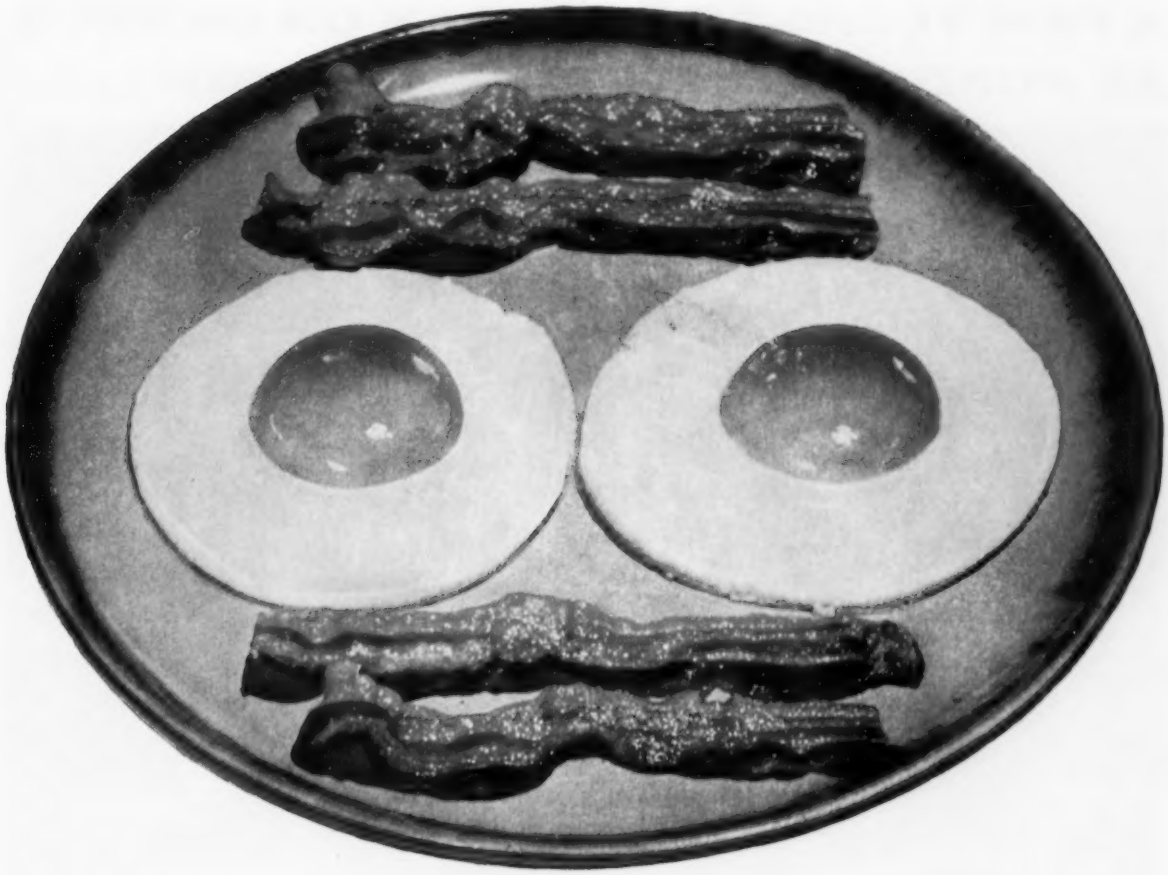
There are many *kinds* of work to try: Design engineering, application, research, manufacturing, sales. Over 90 training stations are available, with expert guidance when you want it. Your future is as big as your ability can make it.

Or, if you have decided your field of interest and are well qualified, opportunities exist for direct assignments on our engineering staff.

In any case—learn more about Allis-Chalmers. Ask the A-C manager in your territory, or write direct to Allis-Chalmers, Graduate Training Section, Milwaukee 1, Wisconsin.

ALLIS-CHALMERS

A-4685



. . . a combination that's hard to beat!

Laminated plastics . . . for a combination of properties that *can't* be beat

SYNTHANE is a favorite material among engineers, designers, and product-conscious executives because it possesses a combination of many properties. It is light in weight, strong; has high dimensional stability, excellent electrical properties and chemical resistance. It's also easy to fabricate.

Synthane makes excellent ball bearing retainers. High dimensional stability, wear resistance and non-galling properties keep bearings humming smoothly at 100,000 rpm and up! Synthane's light weight minimizes the effect of any eccentricities, provides lower starting torques, less bearing weight. The Synthane plant has facilities for producing practically every type of laminated plastic retainer known.

Property combinations! Synthane has them . . . in over 30 individual grades . . . sheets, rods, tubes, moldings and completely fabricated parts. Send for free illustrated catalog today.

EASILY MACHINED

DIELECTRIC STRENGTH

TENSILE STRENGTH

CHEMICAL RESISTANCE

SYNTHANE

SYNTHANE CORPORATION, 13 RIVER ROAD, OAKS, PA.

A FEW YEARS AGO, HE WAS ON CAMPUS AT PURDUE UNIVERSITY, AND NOW...

FLOYD D. (Doug) WALLACE, JR., above, is a senior project engineer at Allison.

He left Purdue in 1947 with his AE degree and came to Allison the same year. Presently, he is in charge of instrumentation and automatic process controls at Allison's new Research & Development test center.

With Allison now in the midst of a $75 million engineering expansion and building program, much of his time is spent in vendor contact work, studying and selecting equipment most adequate to do the job; observing, and helping with installation. He is shown above checking a control valve positioning amplifier on the instrument panel for controlling air pressures and temperatures of four electric motor-driven, axial flow compressors. This new facility is part of the new Research and Development test center, which—when completed—will enable testing of individual combustion components for turbo-prop and turbo-jet engines, compressor and turbine components.

Doug's work is "cut out" for him for some time to come, for only recently, Allison broke ground for the engineering building which is to be the center of expanded Research and Development facilities for advanced types of aircraft engines for commercial and military use.

With this long-range expansion program, Allison needs more engineering personnel, and opportunity for young graduate engineers is unlimited. Arrange now for an early interview with our representative on your campus, or write for information about the possibilities of YOUR engineering career at Allison: Personnel Dept., Engineering College Contact, Allison Division, General Motors Corporation, Indianapolis 6, Indiana.

ALLISON
TURBO-PROP ENGINES
American built for the new era in air travel

From college to business is a big jump. So, before deciding on that all-important first job, you need *specific* information on what various companies have to offer.

Westinghouse is prepared to give it to you. In a personal conference, The Man With The Facts will give you a complete story on career opportunities at Westinghouse.

Before deciding on your first job see the Westinghouse Man With The Facts

He will tell you about its million-dollar Educational Center and comprehensive training program in classroom and plant . . . the many kinds of careers open . . . opportunities for further education and advancement, and how other graduates took advantage of these to reach interesting and responsible positions.

The Westinghouse $300,000,000 expansion program is constantly opening up new fields and opportunities for young men. Let The Man With The Facts tell you about them.

So you can size up Westinghouse, ask your Placement Officer to make a date with The Man With The Facts. Send now, for copies of booklets offered below.

G-10292

YOU CAN BE SURE...IF IT'S

Westinghouse

Ask your Placement Officer about career opportunities at Westinghouse, or write for these two booklets: *Continued Education at Westinghouse* (describing our Graduate Study Program) and *Finding Your Place in Industry.*

Write: Mr. P. B. Shiring, Regional Educational Co-ordinator, Westinghouse Electric Corporation, 40 Wall Street, New York 5, New York.

Civil Engineering Honor System

Reprinted from the Cornell Daily Sun

Cheating on exams, homework, and lab reports at Cornell is not represented by isolated instances, but in some cases is widespread and recognized by faculty. There remain at this University, "Freedom and Responsibility" notwithstanding, students who lack the integrity, or perhaps only the maturity to do their own work.

Among Cornellians who are dishonest in their studies are many who have some moral convictions against cheating. These easily tempted people who cheat "occasionally" might be considerably helped if there existed at the University strong pressure for a mature approach to studies.

An honor system, among other possibilities, can reduce cheating. The Civil Engineering School has been operating under an honor system for about fifty years. A recent survey indicates that there is less under the honor system than even in other engineering courses.

The reason the honor system works is not easy to find. It certainly does not work because students under the system report classmates they see cheating. Only very rarely in the years of opration of the C.E. system has one student reported another. Even though students do not report others who cheat, there is created a strong sentiment against cheating. Social pressure is great enough, and the complete lack of respect for a cheater by his classmates is sufficient to disuade the easily tempted from dishonesty. Perhaps the only function of the honor system is to make the student aware that a mature approach to coursework is expected.

The honor system in C.E. is a student-initiated and managed institution which has been in continuous operation since 1907. The existing form of honor system is a slight variation from the original form, however the spirit of this code has remained unaltered.

The present code, revised in 1949, and approved unanimously by the students in C.E. has as its central administrative body the Honor Committee. This group is representative of the entire school, electing two members from each class, and handles all violations of the code. The committee recommends to the faculty any action that is to be taken against a violator of the code. It is interesting to note that the faculty has never failed to approve the recommendations of the committee.

The primary duty of the Honor Committee is to keep the ideas of the code before the student body. This is done by explaining the code to freshmen as part of the orientation program. Responsibility to the code is especially emphasized. This may involve reporting another person or just effectively maintaining one's own honor. A second means of keeping the ideas of the honor system before the students is accomplished by placing a pledge at the top of each examination paper. The student signs this pledge, acknowledging that he neither gave nor eccepted aid on the exam.

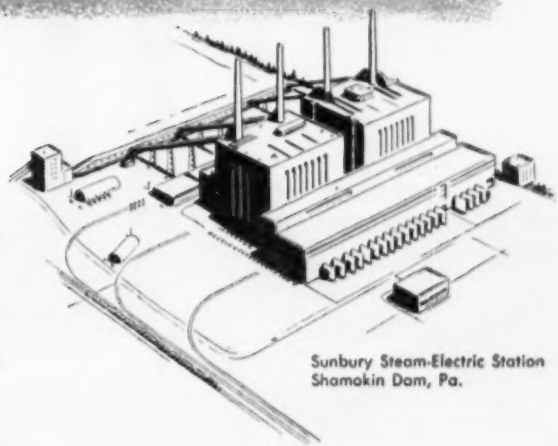
The Student Engineering Council would like to acquaint students in engineering, and the entire student body with an honor system that has worked successfully for many years. An honor system is not the only solution to a cheating problem, and perhaps it is not the best solution.

In engineering courses the question of what constitutes honorable work on lab reports and homework is not always clearcut. In this regard the Engineering Council is conducting a survey of opinion in the College of Engineering on introducing an honor system patterned after that in C.E. There is no reason why the College of Engineering, or the entire University can not operate on an honor code similar to that in Civil Engineering, if the student body is behind such a proposal. We hope a representative survey of opinion will show this, and would appreciate student cooperation.

—John Baldeschwieler '56
Ken Carlson '56
Student Engineering Council

PENNSYLVANIA POWER & LIGHT COMPANY

. . . an *exclusive* user of
Grinnell
prefabricated piping
for 16 years

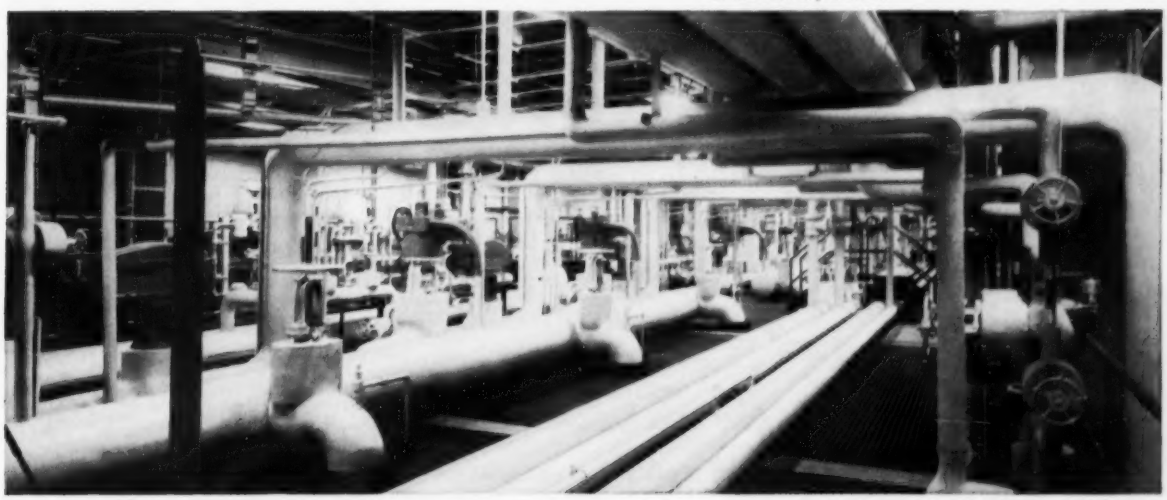


Sunbury Steam-Electric Station
Shamokin Dam, Pa.

Since 1940, Pennsylvania Power & Light Company has awarded *all* its prefabricated piping work to Grinnell. Some idea of the extent of this confidence in the competence and skill of Grinnell piping specialists can be drawn from the fact that during this 16-year period there were 8 new units installed — with a total capability of close to 800,000 kw's.

Among other companies in the power field which have indicated a marked preference in the past for Grinnell Piping Products are Duke Power, a Grinnell Prefabricated

Where some of the 4,500 individual fabricated piping assemblies made by Grinnell were installed at the Sunbury Station.



Piping user for 44 years; New England Electric System, a 6-year, 6-time repeat customer; and Carolina Power & Light, a 7-year, 7-time Grinnell repeat customer.

The big jobs in power piping go to Grinnell because Grinnell's shop facilities offer these practical advantages . . . superior quality of finished product; faster "on the job" assembly; lower final cost.

Work done by Grinnell for Pennsylvania Power & Light Company

1940-41	Cedar Station, Unit #6
1941-42	Hauto Station, Unit #6
1949 . . .	Sunbury Station, Units 1 & 2
1950	Sunbury Station, Unit #3
1953	Sunbury Station, Unit #4
1954 . . .	Martins Creek Sta., Unit #1
(Scheduled Completion)	
1956 . . .	Martins Creek Sta., Unit #2

GRINNELL

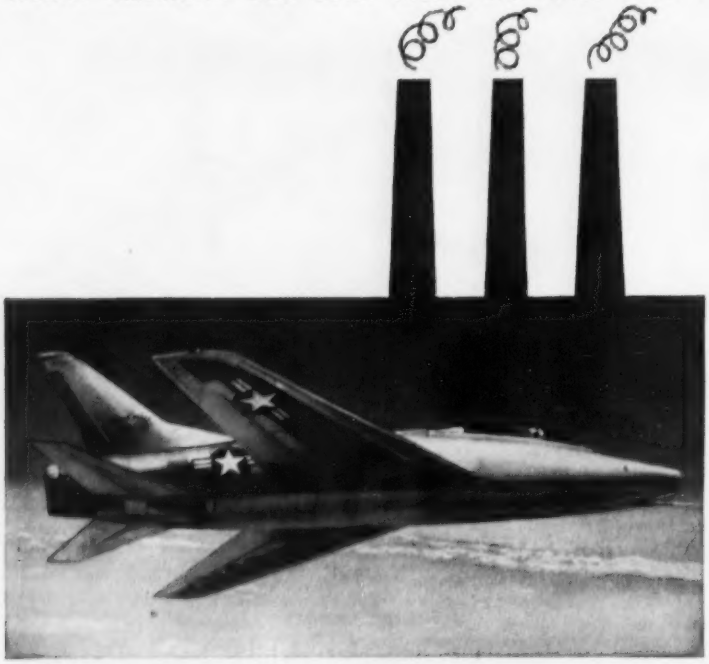
WHENEVER PIPING IS INVOLVED

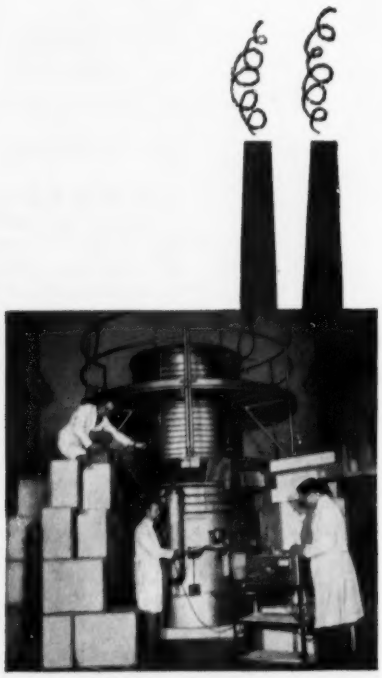
Grinnell Company, Inc., Providence, Rhode Island • Coast-to-Coast Network of Branch Warehouses and Distributors

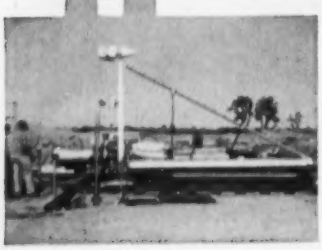
pipe and tube fittings • welding fittings • engineered pipe hangers and supports • Thermolier unit heaters • valves
Grinnell-Saunders diaphragm valves • pipe • prefabricated piping • plumbing and heating specialties • water works supplies
industrial supplies • Grinnell automatic sprinkler fire protection systems • Amco air conditioning systems

ENGINEERING GRADUATES HAVE FOUND ATTRACTIVE OPPORTUNITIES WITH GRINNELL

NORTH AMERICAN HAS BUILT MORE AIRPLANES THAN ANY OTHER COMPANY IN THE WORLD







DIVERSITY CREATES OPPORTUNITY

Although best known for design and production of world-famous aircraft like the Korea-famed F-86 *Sabre* Jet and the new, record-smashing F-100 *Super Sabre* . . . North American Aviation also offers engineers excellent opportunities in other technical fields.

North American needs engineers with imagination to help design and build the aircraft of the future. Other fascinating careers are created daily in its rapidly developing guided missile, jet, propulsion systems, electronic and atomic energy programs.

When you are ready to enter the engineering profession, consider the well-paid opportunities at North American. Meanwhile, write for information on your future in the aircraft industry.

Contact: **Your College placement office or write:**

Engineering Personnel Office
5701 West Imperial Highway,
Los Angeles

12214 South
Lakewood Blvd.,
Downey, Calif.

North American
Aviation, Inc.
Columbus 6, Ohio

ENGINEERING AHEAD FOR A BETTER TOMORROW

NORTH AMERICAN AVIATION, INC.

John E. Young is working toward his B.S. in chemistry from California Institute of Technology this June. He has maintained honor standing in classwork while serving on the school newspaper, in the debating society, and as treasurer of the student body. John is interested in chemical research and development.

John Young asks:

How does research differ from development work at Du Pont?

John B. Aaron worked for Du Pont as a summer laboratory assistant even before he graduated from Princeton with a B.S. in 1940. After military service he obtained an M.S.Ch.E. from M.I.T. and returned to Du Pont in 1947. Over the years he has had many opportunities to observe Du Pont research and development work. Today John is process and methods supervisor at the Philadelphia Plant of Du Pont's Fabrics and Finishes Department.

John Aaron answers:

Well, John, it's hard to define the difference in a way that will satisfy everybody, because one always finds a lot of overlapping between research and development work. But most people agree that there are differences, especially in time sequence. Research work comes first, because one of its main objectives is to establish or discover new scientific facts that will supply the foundation for new industrial developments. In other words, research men seek new knowledge about matter, generally working with small quantities of it.

Development work comes later, and Du Pont has two main types. First, there is *new process* development. Here scientists and engineers modify, streamline, and augment the findings of research so that new chemical products can be profitably made on a large scale—or existing products can be made by newer and more efficient methods. Pilot-plant and semi-works operations are usually included under this heading.

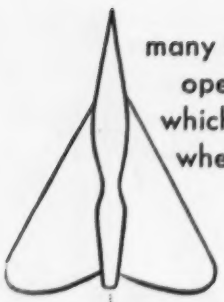
Second, an important kind of development work is directed toward improvement of *existing processes and products*. Here the men study how to obtain yield increases, utilize by-products, increase outputs, and solve sales service problems as they arise. This may require considerable research, and that brings us back to the overlapping I previously mentioned.

There are genuine differences, John, but a good deal of similarity, too—especially in the constant need for imagination and creative effort. I think you'll find that research and development work are equally challenging and rewarding at Du Pont.

WANT TO KNOW MORE *about working with Du Pont? Send for a free copy of "Chemical Engineers at Du Pont," a booklet that tells you about pioneering work being done in chemical engineering—in research, process development, production and sales. Write to E. I. du Pont de Nemours & Co. (Inc.), 2521 Nemours Bldg., Wilmington 98, Delaware.*

DU PONT
REG. U.S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY
Enjoy "Du Pont Cavalcade Theater" on Television



many doors will be opened to you... which will you enter when you become an

engineer

OPPORTUNITY KNOCKS for engineering careers at this magnificent new jet aircraft equipment plant

Make the *right* choice when you begin to invest your hard-won skill and knowledge in engineering. Hamilton Standard offers a plant where initiative and responsibility are encouraged . . . where young men are in top management posts . . . an engineering staff which has been continuously expanding for 35 years . . . a plant which has been judged one of the top 10 in the nation. You don't just fill a position at H-S . . . you commence a career! Some of Hamilton's present projects include jet fuel controls, jet turbine starters, hydraulic pumps, air cycle and vapor refrigeration systems, controls and accessories for nuclear engines, propellers for turbine and piston engines.

GRADUATE PROGRAM . . . while at Hamilton Standard you will be encouraged to take advantage of the company's liberal tuition assistance plan and to pursue postgraduate studies at nearby Hartford Graduate Center of Rensselaer Polytechnic Institute.

HAMILTON STANDARD

Send for "YOU AND YOUR FUTURE"

. . . a colorful brochure picturing and describing all of the activities and opportunities at H-S . . . plus information on the graduate engineering program. Write Mr. T. K. Bye, (111) Bradley Field Road, Windsor Locks, Connecticut.

HAMILTON STANDARD A DIVISION OF UNITED AIRCRAFT CORPORATION

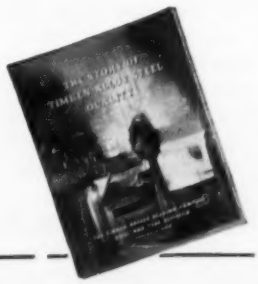
Another page for **YOUR STEEL NOTEBOOK**

The bomb that's built not to explode

This cylinder is called an accumulator. It's used in aircraft to store hydraulic pressure, principally for raising and lowering landing gear and wing flaps. Its working pressure amounts to 3,000 pounds per square inch—so great that faulty material or construction would cause the accumulator to burst with the deadly power of a bomb. The manufacturer was having trouble with variations in the strength and quality of the steel being used. Defects showed up after machining. Rejects were running at a high rate.

The manufacturer called in metallurgists of the Timken Company for help in solving the problem. They recommended a certain analysis of Timken fine alloy seamless steel tubing, specially heat-treated for this application. Result: since switching to Timken fine alloy steel, the Company reports each accumulator can be tested safely at 6,000 pounds per square inch—twice its working capacity—and that rejects are now a rarity.

Want to learn more about steel or job opportunities?



Some of the engineering problems you'll face after graduation will involve steel applications. For help in learning more about steel, write for your free copy of "The Story of Timken Alloy Steel Quality." And for more information about the excellent job opportunities at the Timken Company, send for a copy of "This is Timken." Address: The Timken Roller Bearing Company, Canton 6, Ohio.

YEARS AHEAD—THROUGH EXPERIENCE AND RESEARCH

TIMKEN
Fine Alloy
STEEL

SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS TUBING

STRESS and STRAIN...

Secretary—"Professor, isn't this the same test you gave last semester?"

Prof.—"Yes, but it's alright—I've changed the answers."

* * *

Young man transferring from Engineering to Arts would like to trade one good study lamp for comfortable bed.

* * *

"They tell me your wife is outspoken."

"By whom?"

* * *

Golf is a game in which a ball 1½ inches in diameter is placed on on another ball 8,000 miles in diameter. The object is to hit the small ball but not hit the large one.

* * *

Selectee: "They can't make me fight."

Draft board: "Maybe not—but they can take you where the fighting is and let you use your own judgment."

* * *

A psychiatrist visiting an insane asylum noticed one of the patients huddled, all alone in a corner, busily scratching. "Why do you spend your time there scratching your self?" he asked.

"Because," said the inmate, "I'm the only person in all the world that knows where I itch."

* * *

First C.E.: A woman's greatest attraction is her hair.

Second C.E.: I say her eyes.

Third C.E.: I'd say her smile.

Fourth C.E.: What's the use of sitting here lying to each other?

* * *

A sign in front of a shoe repair shop pictured styles of rubber heels and a beautiful girl who was saying, "I'm in love with America's number one heel." Underneath in small feminine handwriting someone had added, "Too bad sister, I married him first."

CHEMICAL ANALYSIS OF WOMEN

ATOMIC WEIGHT: Reputed to be 120. Isotopes are known through 90 to 180.

OCCURRENCE: Found both free and combined. In combined state it is found with man.

PHYSICAL PROPERTIES: All colors, sizes and shapes. Seldom found in pure state. Boils at nothing and will freeze without reason. Surface is usually covered with film of paint or oxide in various colors and depths. Unpolished specimen turns green in presence of highly polished one. All varieties melt if used incorrectly. Density is not so great as generally supposed.

CHEMICAL PROPERTIES: Highly explosive and dangerous in inexperienced hands. Extremely active in the presence of men. Possesses great affinity for gold, silver, platinum and all precious stones. Has the ability to absorb great quantities of expensive food and drink. May explode spontaneously when left alone with man. Sometimes yields to pressure. Fresh variety has great magnetic attraction, but ages rapidly.

USE: Chiefly experimental. Efficient cleaning agent. Acts as a positive or negative catalyst in the production of fevers.

UNSOLVED PROBLEM: The thing that mystifies many engineers is the fact that the most streamlined specimens offer the most resistance.

* * *

Fellow to blind date: "I never really believed in reincarnation—but what were you before you died?"

* * *

Prof.: "Can anyone give me the derivation of the word 'Auditorium'?"

Stud.: "Yes, from the word audio, hear, and taurus, bull. A place where you . . ."

Prof.: "That will do!"

The designer sat at his drafting board;
A wealth of knowledge in his head was stored;
Like "What can be done on a radial drill,
Or a turret lathe or a vertical mill?"
But above all things, a knack he had
Of driving gentle machinists mad.
So he mused as he thoughtfully scratched his bean
"Just how can I make this thing hard to machine?"
If he made this body perfectly straight,
The job had ought to come out first rate.
But t'would be so easy to turn and bore
That it would never make a machinist sore.
So he'll put a compound taper there,
And a couple of angles to make 'em swear,
And brass would work for these little gears,
But it's too damned easy to work, he fears,
So just to make the machinist squeal,
He'll make him mill it from tungsten steel!
He'll put those holes that hold the cap
Down underneath where they can't be tapped;
Now if they can make this, it'll be just luck,
'Cause it can't be planed and can't be ground,
So he feels his design is unusually sound,
And he shouted in glee "Success at last!
This damned thing can't even be cast."

* * *

Diner: Waitress, are you sure this ham was cured?

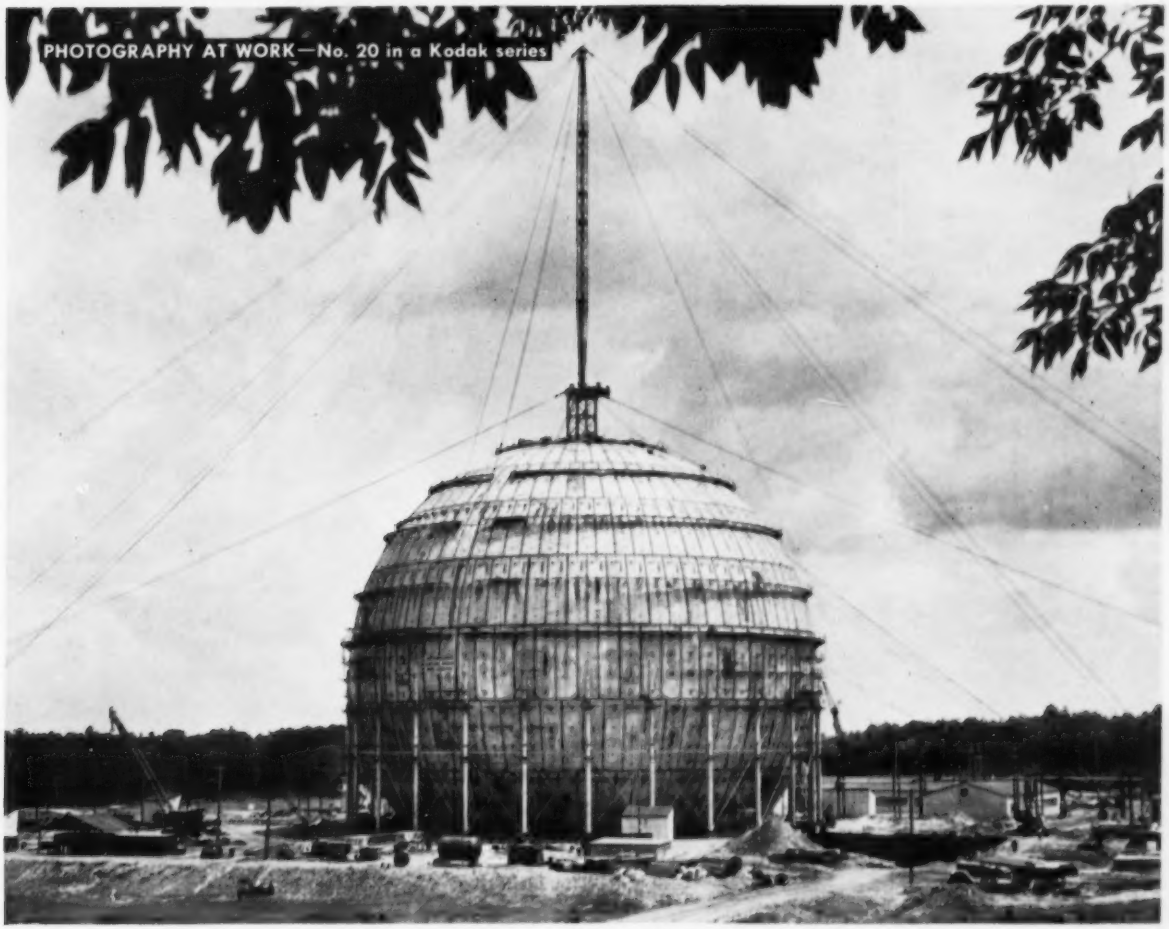
Waitress: Yes, sir.

Diner: Well, it's had a relapse.

* * *

"This college turns out some great men. When did you graduate?

"I didn't graduate, I was turned out."



"Atom Apple," a 225-foot sphere of steel plates welded into virtually one piece.

An egg built to hatch miracles

–and x-ray photography searched every seam in its shell

To test America's nuclear wonders, the Knolls Atomic Power Laboratory uses history's largest steel sphere—with each weld proved sound by x-rays and photography.

This huge steel sphere, ten times larger than man has ever built before, houses the prototype power plant of America's nuclear submarine, Sea Wolf, designed and constructed by the General Electric Co. for the Atomic Energy Commission.

As a safety measure, every seam was welded, making the sphere virtually one piece. And to be positive every weld was sound, it was x-rayed—with proof of its internal bonds recorded on film.

Radiography like this is working today for welders large and small—and for foundries interested in providing flawless castings. And photography in other forms is working for all kinds of business and industry. It is helping solve design problems, increase production, train salespeople, speed up office routine.

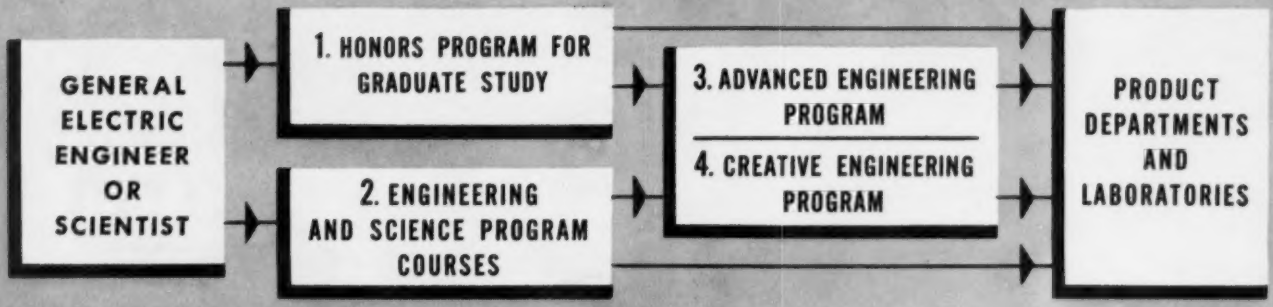
Behind the many photographic products becoming increasingly valuable today and those being planned for tomorrow lie intriguing and challenging opportunities at Kodak in research, design and production.

If you are interested in these opportunities in science and engineering—whether you are a recent graduate or a qualified returning serviceman, write to the Business and Technical Personnel Department.

Kodak
TRADE MARK

Eastman Kodak Company, Rochester 4, N. Y.

G.E. announces new Honors Program: latest addition to advanced-study opportunities


GENERAL ELECTRIC ENGINEER OR SCIENTIST
1. HONORS PROGRAM FOR GRADUATE STUDY
2. ENGINEERING AND SCIENCE PROGRAM COURSES
3. ADVANCED ENGINEERING PROGRAM
4. CREATIVE ENGINEERING PROGRAM
PRODUCT DEPARTMENTS AND LABORATORIES

Further formal education as you learn and earn at General Electric

(1) Honors Program

G.E. selects qualified employees and reimburses them for tuition, fees, and books in connection with graduate study at universities located near G-E operations. You may participate in the tuition refund plan in one of two ways in selected G-E plant locations; by taking individual graduate courses while working a normal 40 hour week, or by carrying approximately one-half an academic load while working a reduced 20-hour week. You work full time and receive full pay during the summer months, unless time for thesis work is required.

(2) Engineering and Science Program Courses

Covering a variety of subjects—from engineering and production problems to product design and advanced physics—these G-E courses are the stepping stones to either the Advanced, or Creative Engineering Programs.

ADVANCED TECHNICAL COURSE consists of actual engineering problems in areas such as dynamics, electromagnetic fields, fluid flow, heat transfer, servomechanisms.

ENGINEERING DESIGN COURSE provides a background in materials, methods, and manufacturing processes, with instruction tailored to improve the engineer's design ability.

You may also take any of the numerous Specialized Technical and Departmental Courses that are continually offered.

(3) Advanced Engineering Program

To select and train technical leaders, this program combines extensive class and home assignments, with a 36-hour work week in association with Company technical leaders. The program is rigorous but the hard work pays off, for since its founding in 1923, 75% of its graduates have become engineering specialists and managers. Selection for the program requires either a Masters Degree or graduation from the Advanced Technical Course.

(4) Creative Engineering Program

This course is designed to help you make maximum use of your imagination and resourcefulness in solving problems and contributing new ideas. The number of patents registered by graduates of this program is almost double that of other engineers in General Electric. The one-year graduate-level Company course presents the latest techniques in creative engineering. Problems are worked on an individual basis or team basis. Complete facilities are available for construction of models and prototypes needed to demonstrate and develop any ideas.

For complete information write Mr. W. S. Hill, Engineering Services, Bldg. 36, General Electric Company, Schenectady 5, New York.

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Progress Is Our Most Important Product

GENERAL ELECTRIC

G.E.'s CLARENCE H. LINDER, Vice President—Engineering, defines the challenge of technology.

ENGINEERS IN INDUSTRY

Industrial progress hinges on the engineers' ability to apply amazingly complex technology to the problem of creating new goods and services. It is vital that the engineer at G.E. be given every opportunity for self-development in his chosen field, and so the far-reaching educational programs described on this page are designed to satisfy three specific needs.

The Team Approach

The team approach to complex technical projects is extremely important in industry today. It brings together competent men with a wide variety of training and experience to blend their abilities in the solution of problems. To be prepared to work as a member of a team, the engineer must develop appreciation and understanding of the work and contribution of the other members. Recognition of this need is the basis of teaching philosophy all through the programs.

Importance of Supporting Sciences

Many of the problems facing engineers in modern industry are not found in the principal engineering sciences, but have shifted into areas which have been thought of as supporting sciences. An engineer working principally in aerodynamics, for example, may find the main roadblocks in his work are the limitations of the materials which are available. By working closely with experts in the field, the engineer must in fact influence the development of new and better materials.

Broad Technical Backgrounds

The solid core of industry's engineering effort is a body of men thoroughly grounded in the fundamentals of basic science. With the explosive increase in technology, the engineer and scientist need to keep abreast of all allied areas. G-E advanced-study programs give this opportunity.